Notice

Throughout this publication, Dangers, Warnings and Cautions (accompanied by the International HAZARD Symbol ⚠) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. **OBSERVE THEM CAREFULLY!**

These Safety Alerts alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus common sense operation, are major accident prevention measures.

⚠ DANGER

Immediate hazards which will result in severe personal injury or death.

⚠ WARNING

Hazards or unsafe practices which could result in severe personal injury or death.

⚠ CAUTION

Hazards or unsafe practices which could result in minor personal injury or product or property damage.

Notice to Users of This Manual

This service manual has been written and published by the Service Department of Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with marine product servicing procedures. Furthermore, it is assumed that they have been trained in the recommended service procedures of Mercury MerCruiser product, including the use of mechanics' common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the marine trade of all conceivable procedures and of the possible hazards and/or results of each method. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product's safety will be endangered.

All information, illustrations, and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell and/or service these products.

We reserve the right to make changes to this manual without prior notification.

Refer to dealer service bulletins, operation maintenance and warranty manuals and installation manuals for other pertinent information concerning the products described in this manual.

Precautions

It should be kept in mind, while working on the product, that the electrical system and ignition system are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note, during any maintenance procedure replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, while most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for reuse in the same locations whenever possible. Where the fasteners are not satisfactory for reuse, care should be taken to select a replacement that matches the original.

Engine Mechanical Components

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide open throttle operation and, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications that are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Replacement Parts

Use of parts other than the recommended service replacement parts will void the warranty on those parts that are damaged as a result.

⚠ WARNING

Electrical, ignition, and fuel system components on Mercury MerCruiser Engines and Sterndrives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition, or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition, and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Models Covered in This Manual

Carbureted Models

Sterndrive (MCM)	Serial Number
5.0L Alpha and Bravo	0M087348 and Above
5.7L Alpha and Bravo	

Inboard (MIE)	Serial Number
5.7L	0L677227 and Above

Tow Sports (MIE)	Serial Number
5.7L	0L677946 and Above

MPI Models

Sterndrive (MCM)	Serial Number
5.0L MPI Alpha and Bravo	0M300000 and Above
350 MAG MPI Alpha and Bravo	
350 MAG MPI Bravo Horizon	
MX 6.2 MPI	
MX 6.2 MPI Horizon	

Inboard (MIE)	Serial Number
350 MAG MPI Inboard	0M310000 and Above
350 MAG MPI Horizon Inboard	
MX 6.2 MPI Inboard	
MX 6.2 MPI Horizon Inboard	

Tow Sports (MIE)	Serial Number
350 MAG MPI	0M310000 and Above
Black Scorpion	0M391600 and Above
MX 6.2 MPI	0M310000 and Above
MX 6.2 Black Scorpion	0M391750 and Above

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Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs or tune-up, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

How To Use This Manual

This manual is divided into sections which represent major components and systems.

Some sections are further divided into parts that more fully describe the component.

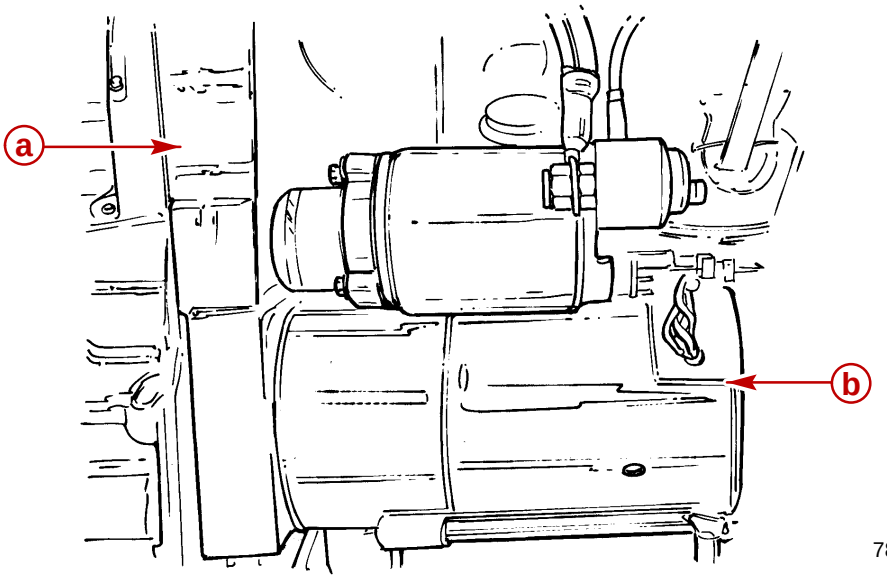
Refer to the Service Manual Outline following Models Covered In This Manual for section titles.

Page Identification

The service manual number and section title appear at the top of the page. Two number groups appear at the bottom of each page. Following is an example and a description.

a - Section number
b - Section part
c - Page number
d - Manual number
e - Revision number
f - Month printed
g - Year printed

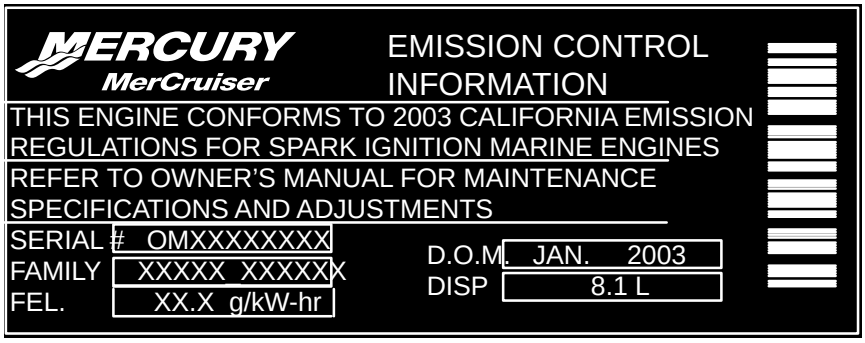
Engine Serial Number Locations



78018

a - Serial number plate
b - Starter motor

Emission Control Information Label



79005

"SERIAL#" - Engine Serial Number

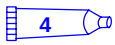
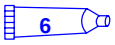
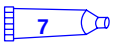
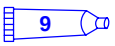
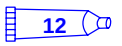
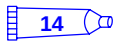
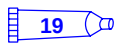
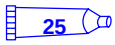
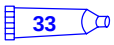
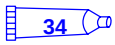
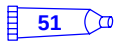
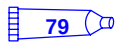
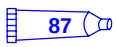
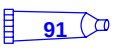
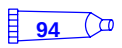
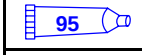
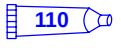
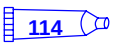
"FAMILY" - Engine Family

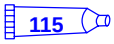
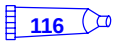
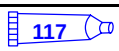
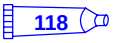
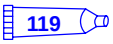
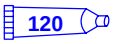
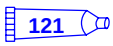
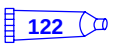
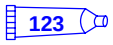
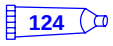
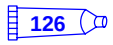
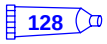
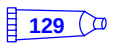
"FEL." - Family Emission Limit

"D.O.M." - Date of Manufacture

"DISP" - Piston Displacement

Mercury/Quicksilver Lubricants, Sealants And Adhesives

Tube Ref. #	Description	Container Size	Mercury Part Number	Quicksilver Part Number
	Needle Bearing Assy. Lubricant	8 oz (226.8 g) tube	N/A	92-802868A1
	Dielectric Grease	8 oz (226.8 g) can	N/A	92-823506-1
	Loctite 271 - Thread Locker	10 ml tube	N/A	92-809819
	Loctite 567 PST Pipe Sealant	50 ml tube	N/A	92-809822
	Loctite Master Gasket Kit		N/A	92-12564-2
	2 Cycle Premium Outboard Oil	1 US qt (0.94 L)	92-802813A1	92-802813Q1
	Perfect Seal	16 oz (0.45 kg) can	N/A	92-34227-1
	Liquid Neoprene	8 oz (226.8 g) can	N/A	92-25711-3
	Bellows Adhesive	1.5 oz (42.5 g) tube	N/A	92-86166Q1
	Loctite 680 Retaining Compound	10 ml tube	N/A	92-809833
	Special Lubricant 101	8 oz (226.8 g) tube	92-802865A1	92-802865Q1
	U-Joint and Gimbal Bearing Grease		92-802870A1	92-802870Q1
	Loctite 222 Thread Locker	10 ml tube	N/A	92-809818
	Loctite 242 Thread Locker	10 ml tube	N/A	92-809821
	4 Cycle 25W40 Engine Oil		92-802837A1	92-802837Q1
	Premium Gear Lubricant	1 US qt (0.94 L)	92-802846A1	92-802846Q1
	High Performance Gear Lube	1 US qt (0.94 L)	92-802854A1	92-802854Q1
	Engine Coupler Spline Grease	14 oz (0.39 kg) cartridge	92-802869A1	92-802869Q1
	Anti-Corrosion Grease	8 oz (226.8 g) tube	92-802867A1	92-802867Q1
	2-4-C with Teflon	8 oz (226.8 g) tube	92-802859A1	92-802859Q1
	4 Stroke 10W30 Outboard Oil	1 US qt (0.94 L)	92-802833A1	92-802833Q1
	Power Trim & Steering Fluid	8 oz (226.8 g)	92-802880A1	92-802880Q1

Tube Ref. #	Description	Container Size	Mercury Part Number	Quicksilver Part Number
	Premium Plus 2 Cycle TC-W3 Outboard Oil	1 US qt (0.94 L)	92-802824A1	92-802824Q1
	RTV 587 Silicon Sealer	3 oz (85.05 g)	N/A	92-809825
	Loctite 7649 Primer N	4.5 oz (127.57 g)	N/A	92-809824
	Storage Seal Rust Inhibitor	12 oz (325 ml) spray can	92-802878-56	92-802878Q56
	Corrosion Guard	12 oz (325 ml) spray can	92-802878 55	92-802878Q55
	15W40 4-cycle Diesel Engine Oil	1.06 US gal.(4 L)	92-877695K1	92-877695Q1
	Extended Life Antifreeze/Coolant	1 US gal. (3.78 L)	92-877770K1	92-877770K1
	Marine Engine Coolant	1.33 US gal. (5 L)	N/A	92-813054A2
	Fuel System Treatment and Stabilizer Concentrate	16 oz (437 ml)	92-802876A1	92-802876Q1
	Heat Transfer Compound	1.5 oz (42.5 g) tube	N/A	92-805701 1
	Liquid Gasket		N/A	92-808137
	T442 Sealant		N/A	92-862258
	Loctite 5900 Ultra Black RTV Silicone Sealant	13 oz (371 g) tube	N/A	92-809826
	Loctite Gasket Remover	18 oz (532 ml) spray can	N/A	92-809828 1
	Sealer Kit, Two Part Epoxy		N/A	92-65150 1
	Dexron III Automatic Transmission Fluid		Obtain Locally	Obtain Locally
	Loctite 592		Obtain Locally	Obtain Locally
	Loctite Quick Tite		Obtain Locally	Obtain Locally
	Isopropyl Alcohol		Obtain Locally	Obtain Locally
	Hot Glue		Obtain Locally	Obtain Locally
	Loctite 609		Obtain Locally	Obtain Locally
	Loctite 405		Obtain Locally	Obtain Locally
	Cyanacrylate Adhesive		Obtain Locally	Obtain Locally
	3M Permabond #3M08155		Obtain Locally	Obtain Locally
	Loctite 262		Obtain Locally	Obtain Locally

NOTES:

IMPORTANT INFORMATION

Section 1B - Maintenance

1 B

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Engine And Tune-Up Specifications

MPI MCM (Sterndrive) Models

Models	5.0 L MPI	350 MAG MPI	350 MAG MPI Horizon	MX 6.2 MPI	MX 6.2 MPI Horizon
Horsepower[1]	260	300		320	
Kilowatts[1]	194	224		238	
Number of cylinders	V8				
Displacement	5.0 liter (305 cid)	5.7 liter (350 cid)		6.2 liter (377 cid)	
Bore/Stroke mm (in.)	95 x 88.4 (3.74 x 3.48)	101.6 x 88.4 (4.0 x 3.48)		101.6 x 95.25 (4.0 x 3.75)	
Compression ratio	9.4:1	9.3:1		9.0:1	
Compression pressure	Minimum 670 kPa (100 psi)[4]				
Specified WOT rpm range[2]	4600-5000			4800-5200	
Idle rpm in NEUTRAL[2]	600 rpm[3]				
Minimum oil pressure @ 2000 rpm [5]	Minimum 124 kPa (18 psi)				
Minimum oil pressure @ Idle[5]	Minimum 41 kPa (6 psi)				
Fuel pressure (1800 rpm)	296 kPa (43 psi)				
Thermostat, seawater cooled models	71 degrees C (160 degrees F)				
Thermostat, closed cooled models	71 degrees C (160 degrees F)				
Thermostat, closed cooled models (dry joint only)	77 degrees C (170 degrees F)				
Timing @ idle[3]	Not Adjustable				
Firing order	1-8-4-3-6-5-7-2				
Electrical system	12-Volt Negative (–) Ground				
Alternator rating - hot operating amps	65 Amps				
Alternator rating - cold operating amps	72 Amps				
Minimum recommended battery rating	750 cca, 950 mca, or 180 Ah				
Spark plug type	AC Platinum (AC 41-932)				
Spark plug gap	0.060 in (1.52 mm)				

[1] *Performance obtained and corrected in accordance with SAE J1228 Crankshaft Power.*

[2] *Measured using an accurate service tachometer, with the engine at normal operating temperature.*

[3] *Idle speed on MPI models is not adjustable.*

[4] *Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.*

[5] *Oil pressure must be checked with the engine at normal operating temperature.*

Engine And Tune-Up Specifications (continued)

MPI MIE (Inboard) Models

Models	350 MAG MPI	350 MAG MPI Horizon	MX 6.2 MPI	MX 6.2 MPI Horizon
Horsepower[1]	300		315	320
Kilowatts[1]	224		235	239
Number of cylinders	V8			
Displacement	5.7 liter (350 cid)		6.2 liter (377 cid)	
Bore/Stroke mm (in.)	101.6 x 88.4 (4.0 x 3.48)		101.6 x 95.25 (4.0 x 3.75)	
Compression ratio	9.3:1		9.0:1	
Compression pressure	Minimum 670 kPa (100 psi)[4]			
Specified WOT rpm range[2]	4400-4800		4600-5000	
Idle rpm in NEUTRAL[2]	600 rpm[3]			
Minimum oil pressure @ 2000 rpm[5]	Minimum 124 kPa (18 psi)			
Minimum oil pressure @ Idle[5]	Minimum 41 kPa (6 psi)			
Fuel pressure (1800 rpm)	296 kPa (43 psi)			
Thermostat, seawater cooled models	71 degrees C (160 degrees F)			
Thermostat, closed cooled models	71 degrees C (160 degrees F)			
Thermostat, closed cooled models (dry joint only)	77 degrees C (170 degrees F)			
Timing @ idle[3]	Not Adjustable			
Firing order	1-8-4-3-6-5-7-2			
Electrical system	12-Volt Negative (–) Ground			
Alternator rating - hot operating amps	65 Amps			
Alternator rating - cold operating amps	72 Amps			
Minimum recommended battery rating	750 cca, 950 mca, or 180 Ah			
Spark plug type	AC Platinum (AC 41-932)			
Spark plug gap	0.060 in (1.52 mm)			

[1] *Performance obtained and corrected in accordance with SAE J1228 Crankshaft Power.*

[2] *Measured using an accurate service tachometer, with the engine at normal operating temperature.*

[3] *Idle speed on MPI models is not adjustable.*

[4] *Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.*

[5] *Oil pressure must be checked with the engine at normal operating temperature.*

Engine And Tune-Up Specifications (continued)

MIE (Tow Sports) Models

Models	350 MAG MPI	5.7L Black Scorpion	MX 6.2 MPI	MX 6.2 Black Scorpion
Horsepower[1]	300	330	315	340
Kilowatts[1]	235	246	235	254
Number of cylinders	V8			
Displacement	5.7 liter (350 cid)		6.2 liter (377 cid)	
Bore/Stroke in. (mm)	101.6 x 88.4 (4.0 x 3.48)		101.6 x 95.25 (4.0 x 3.75)	
Compression ratio	9.3:1		9.0:1	
Compression pressure	Minimum 670 kPa (100 psi) [4]			
Specified WOT rpm range[2]	4600-5000	4800-5200	4600-5000	4800-5200
Idle rpm in NEUTRAL[2]	600 rpm[3]			
Minimum oil pressure @ 2000 rpm[5]	Minimum 124 kPa (18 psi)			
Minimum oil pressure @ Idle[5]	Minimum 41 kPa (6 psi)			
Fuel pressure (1800 rpm)	296 kPa (43 psi)			
Thermostat, seawater cooled models	71 degrees C (160 degrees F)			
Thermostat, closed cooled models	71 degrees C (160 degrees F)			
Thermostat, closed cooled models (dry joint only)	77 degrees C (170 degrees F)			
Timing @ idle[3]	Not Adjustable			
Firing order	1-8-4-3-6-5-7-2			
Electrical system	12-Volt Negative (–) Ground			
Alternator rating - hot operating amps	65 Amps			
Alternator rating - cold operating amps	72 Amps			
Minimum recommended battery rating	750 cca, 950 mca, or 180 Ah			
Spark plug type	AC Platinum (AC 41-932)			
Spark plug gap	0.060 in (1.52 mm)			

[1] *Performance obtained and corrected in accordance with SAE J1228 Crankshaft Power.*

[2] *Measured using an accurate service tachometer, with the engine at normal operating temperature.*

[3] *Idle speed on MPI models is not adjustable.*

[4] *Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.*

[5] *Oil pressure must be checked with the engine at normal operating temperature.*

Engine And Tune-Up Specifications (continued)

Carbureted Models

Models	5.0L Sterndrive Models	5.7L Sterndrive Models	5.7L Inboard Models	5.7L Tow Sports Models
Horsepower[1]	220	250	260	270
Kilowatts[1]	164	186	194	201
Number of cylinders	V8			
Displacement	5.0 liter (305 cid)	5.7 liter (350 cid)		
Bore/Stroke in. (mm)	95 x 88.4 (3.74 x 3.48)	4.0 x 3.48 (101.6 x 88.4)		
Compression ratio	9.4:1	9.3:1		
Compression pressure	Minimum 670 kPa (100 psi)[4]			
Specified WOT rpm range[2]	4400-4800			
Idle rpm in NEUTRAL[2]	650 rpm[3]			
Minimum oil pressure @ 2000 rpm[5]	Minimum 124 kPa (18 psi)			
Minimum oil pressure @ Idle[5]	Minimum 41 kPa (6 psi)			
Fuel pressure (1800 rpm)	296 kPa (43 psi)			
Thermostat, seawater cooled models	71 degrees C (160 degrees F)			
10° BTDC	Not Adjustable			
Firing order	1-8-4-3-6-5-7-2			
Electrical system	12-Volt Negative (–) Ground			
Alternator rating - hot operating amps	65 Amps			
Alternator rating - cold operating amps	72 Amps			
Minimum recommended battery rating	750 cca , 950 mca , or 180 Ah			
Spark plug type	AC Platinum (ACMR43LTS)			
Spark plug gap	0.045 in. (1.1 mm)			

[1] *Performance obtained and corrected in accordance with SAE J1228 Crankshaft Power.*

[2] *Measured using an accurate service tachometer, with the engine at normal operating temperature.*

[3] *Idle speed on MPI models is not adjustable.*

[4] *Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.*

[5] *Oil pressure must be checked with the engine at normal operating temperature.*

Fluid Specifications

IMPORTANT: It may be necessary to adjust oil levels depending on the installation angle and the cooling systems (the heat exchanger and the fluid lines).

Engines

NOTE: *Measure oil with boat in the water.*

NOTE: *All capacities are approximate fluid measures.*

MPI MODELS

MPI models	Capacity liters (U.S. qt)	Fluid type
Engine Oil (with filter)[1]	5.20 (5-1/2)	4-cycle 25W40 Engine Oil
Seawater Cooling System[2]	20 (21)	Propylene Glycol and Purified Water
Closed Cooling System	19 (20)	Extended Life Antifreeze/Coolant or Extended Life Ethylene Glycol 5/100 Antifreeze/Coolant mixed 50/50 with Purified Water

[1] *Always use the dipstick to determine the exact quantity of oil or fluid required.*

[2] *Seawater Cooling System capacity information is for winterization use only.*

CARBURETED MODELS

Carbureted models	Capacity liters (U.S. qt)	Fluid type
Engine Oil (with filter)[1]	4.7 (5)	4-Cycle 25W40 Engine Oil
Seawater Cooling System [2]	20 (21)	Propylene Glycol and Purified Water

[1] *Always use the dipstick to determine the exact quantity of oil or fluid required.*

[2] *Seawater Cooling System capacity information is for winterization use only.*

Sterndrives

NOTE: *All capacities are approximate fluid measures.*

NOTE: *Drive unit oil capacity includes the gear lube monitor.*

Model	Capacity liters (U.S. qts)	Fluid type
Alpha One	1.89 (2)	High Performance Gear Lube
Bravo One	2.60 (2.75)	
Bravo Two	3.08 (3.26)	
Bravo Three	2.84 (3)	

Transmissions

NOTE: *All capacities are approximate fluid measures.*

NOTE: *Always use the dipstick to determine the exact fluid level.*

Model	Capacity Liters (U.S. qt)	Fluid Type
5000A	2.84 (3)	Dexron III Automatic Transmission Fluid or Equivalent
5000V	3.30 (3-1/2)	
71C In-Line[1]	1.66 (1-3/4)	Mobil 424 or Dexron III Automatic Transmission Fluid Do Not Mix!
71C Gear Reduction[1]	2.84 (3)	
71C Remote V-Drive[1]	1.66 (1-3/4)	
72C In-Line[2]	1.66 (1-3/4)	Mobil 424 or Universal Tractor Hydraulic Oil Do Not Mix!
72C Gear Reduction[2]	1.66 (1-3/4)	
72C Remote V-Drive[2]	1.66 (1-3/4)	
72C V-Drive[2]	3.79 (4)	
63A	4.00 (4-1/2)	Dexron III Automatic Transmission Fluid
63IV	4.00 (4-1/2)	

[1] *71C transmission displays a RED identification label*

[2] *72C transmission displays a GREEN identification label*

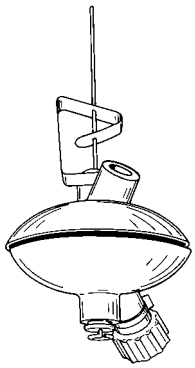
Lubricants / Sealants / Adhesives

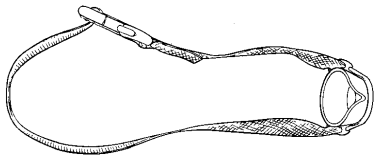
Description	Where Used	Part Number
2-4-C with Teflon	Hinge pins	92-802859A1
	Propeller shaft	
	Pivot points	
	Guide contact surfaces	
	Poppet ball and holes	
U-joint and Gimbal Bearing Grease	Sterndrive unit U-joint crosses and bearings	92-802870A1
	Drive shaft	
	Gimbal bearings	
High Performance Gear Lube	Propeller shaft	92-802854A1
Engine Coupler Spline Grease	Engine coupler splines, U-joint shaft splines	92-802869A1
Dexron III Automatic Transmission Fluid	Power steering system	Obtain Locally
Engine Oil	Pivot points, guide contact surface, starter motor, detent ball and holes, water separating fuel filter sealing ring, oil filter sealing ring	Obtain Locally
2-cycle Premium Outboard Oil	Water separating fuel filter layup	92-802813A1
Power Trim And Steering Fluid	Power trim pump	92-802880A1
	Power steering system	
Corrosion Guard Spray	Power package	92-802878 55
Extended Life Antifreeze/Coolant	Closed cooling system	92-877770K1
Fuel System Treatment and Stabilizer Concentrate	Fuel system	92-802876A1
Fuel System Treatment and Stabilizer	Fuel system	92-802875A1
Premium Plus 2-cycle TC-W3 Outboard Oil	Fuel system	92-802824A1

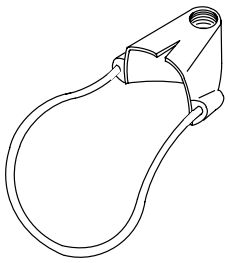
Lubricants / Sealants / Adhesives (continued)

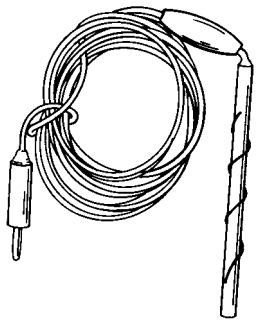
Description	Where Used	Part Number
Loctite 567 PST Pipe Sealant	Fasteners	92-809822
Liquid Neoprene	Electrical connections	92-25711-3
Storage Seal Rust Inhibitor	Carburetor	92-802878-56
Battery terminal sealant	Battery terminals	Obtain locally
Special Lubricant 101	Propeller shaft	92-802865A1
Premium Gear Lubricant	Sterndrive unit	92-802846A1
Loctite 242 Threadlocker	Throttle body studs	92-809821
Anti-Corrosion Grease	Propeller shaft	92-802867A1
Light Gray Primer	Outside of engine	92-802878-52
Phantom Black Paint	Outside of engine	92-802878-1
SAE 10W-30 Engine Oil	Power trim pump	Obtain locally
Loctite 565 PST	Fuel line connectors male pipe threads	Obtain locally

Special Tools

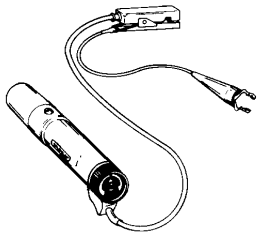
Flushing Device		
 73440	Attaches to the drive unit water intakes; provides a fresh water connection when flushing the cooling system or operating the engine.	91-44357Q2

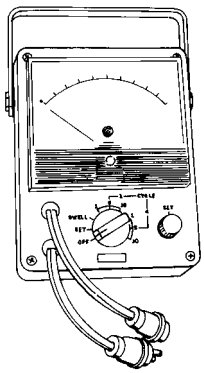
Dual Water Pick-Up Flush Gear Case Seal Kit		
 77977	Use to block-off the front water inlet holes on the dual water inlet gear cases.	91-881150Q1

Flushing Kit		
 78135	Use for flushing sterndrives with low water inlet gear cases.	91-849996T1

Reference Electrode		
 73446	Senses an electrical current in the water when testing the MerCathode system. Use to check hull potential.	91-76675T1

Special Tools (continued)

Portable Timing Light		
 73664	Checks the ignition timing, powered by 2 D-cell batteries.	91-99379

Tachometer / Dwell-Meter		
 73676	Checks the engine rpm (0-10,000). Also, checks the dwell on breaker point ignition systems.	91-59339

Kent-Moore Tools

Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500	
Description	**Part Number**
Kent Moore Belt Tension Gauge	BT-3373-F

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb-in.	lb-ft
Steering lever clamping bolt and nut	67.8		50
Single propeller nut[1]	75		55
	Then align tabs with grooves.		
Front dual propeller nut[1]	136		100
Rear dual propeller nut[1]	81		60
Rear engine mounts	47		35
Flame arrestor bracket nut	12	108	
Fuel line connectors	19-27		14-20
Mounting clip screw	12	108	
Hose clamps	3.4-6.8	30-60	
Distributor clamping screw	25		18
Propeller shaft anode screw 5/16-18 x 1-1/2 in. (38 mm) long	27		20
Throttle body studs	9	80	
Throttle cable bracket nuts	19	168	
IAC screw 1/4-20 x 25 mm (1 in.) long	11	96	
Plenum screw	11	96	
Plenum nut	11	96	
Flame arrestor bracket nut	12	108	
Distributor clamping screw	25		18

[1] *Amount specified is MINIMUM.*

Maintenance Schedules

NOTE: *Only perform maintenance which applies to your particular power package.*

Maintenance Intervals

Maintenance intervals and the corresponding tasks to be performed, as shown in this current schedule or as found in a previously printed schedule, are generally based on an average boating application and environment. However, individual operating habits and personal maintenance preferences can have an impact on the suggested intervals. In consideration of these factors, Mercury MerCruiser has adjusted some maintenance intervals and the corresponding tasks to be performed. In some cases, this may allow for more individual tasks in a single visit to the servicing dealer. Therefore, it is very important that the boat owner and the servicing dealer discuss the current Maintenance Schedule and develop appropriate maintenance intervals to coincide with the individual operating habits, the environment and the maintenance requirements.

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

Gas Sterndrive

Routine Maintenance *	Each Day Start	Each Day End	Weekly	Every Two Months
Check the crankcase oil (interval can be extended based on experience).	★			
If operating in salt, brackish or polluted waters, flush the cooling system after each use.		★		
Check the drive unit oil level, the trim pump oil level and the power steering pump fluid level.			★	
Check the water inlets for debris or marine growth. Check the seawater strainer and clean. Check the coolant level.			★	
Inspect the drive unit anodes and replace if 50 percent eroded.			★	
Lubricate the propeller shaft and retorque the nut (if operating in only freshwater, this maintenance may be extended to every four months).				★
Operating in Saltwater Only: treat the engine surface with corrosion guard.				★
Check the battery connections and the fluid level.				★
Ensure that the gauges and the wiring connections are secure. Clean the gauges.[1]				★ or 50 hours

* Only perform maintenance which applies to your particular power package

[1] *If operating in saltwater, interval is reduced to every 25 hours or 30 days whichever occurs first*

Gas Sterndrive (continued)

Scheduled Maintenance *	Annually	Every 100 hours or Annually ◆	Every 200 hours or 3 years ◆	Every 300 hours or 3 years ◆	Every 2 years	Every 5 years
Touch-up paint the power package and spray with corrosion guard.	★					
Change the crankcase oil and filter.		★				
Change the drive unit oil and retorque the connection of the gimbal ring to the steering shaft.		★				
Replace the fuel filters.		★				
Check the steering system and the remote control for loose, missing or damaged parts. Lubricate the cables and the linkages.		★				
Inspect the U-joints, the splines and the bellows. Check the clamps. Check the engine alignment. Lubricate the U-joint splines.			★			
Lubricate the gimbal bearing and the engine coupler.			★[1]			
Check the continuity circuit for loose or damaged connections. Test the MerCathode® unit output on Bravo Models.			★			
Retorque the engine mounts.				★		
Check the spark plugs, the wires and the distributor cap.				★		
Clean the flame arrestor and the crankcase ventilation hoses. Replace the PCV valve.				★		

* Only perform maintenance which applies to your particular power package

◆ Whichever occurs first

[1] *Lubricate the engine coupler every 50 hours if operated at idle for prolonged periods of time*

Gas Sterndrive (continued)

Scheduled Maintenance *	Annually	Every 100 hours or Annually ◆	Every 200 hours or 3 years ◆	Every 300 hours or 3 years ◆	Every 2 years	Every 5 years
Check the electrical system for loose, damaged or corroded fasteners.				★		
Inspect the condition and the tension of the belts.				★		
Check the cooling system and exhaust system hose clamps for tightness. Inspect both systems for damage or leaks.				★		
Disassemble and inspect the seawater pump and replace worn components.				★		
Clean the seawater section of the closed cooling system. Clean, inspect and test the pressure cap.				★		
Replace the coolant.					♠	★

* Only perform maintenance which applies to your particular power package

◆ Whichever occurs first

♠ Interval will be reduced if not using extended life coolant

Gas Inboard And Tow Sports

Routine Maintenance *	Each Day Start	Each Day End	Weekly	Every Two Months
Check the crankcase oil (interval can be extended based on experience).	★			
If operating in salt, brackish or polluted waters, flush the cooling system after each use.		★		
Check the transmission fluid.			★	
Check the water pickups for debris or marine growth. Check the water strainer and clean. Check the coolant level.			★	
Check the battery connections and the fluid level.				★
Ensure that the gauges and the wiring connections are secure. Clean the gauges.[1]				★ or 50 hours

* Only perform maintenance which applies to your particular power package

[1] *If operating in saltwater, interval is reduced to every 25 hours or 30 days whichever occurs first*

Gas Inboard And Tow Sports (continued)

Scheduled Maintenance *	Annually	Every 100 hours or Annually ◆	Every 200 hours or 3 years ◆	Every 300 hours or 3 years ◆	Every 2 years	Every 5 years	Per OEM
Touch-up paint power package and spray with corrosion guard.	★						
Change the crankcase oil and filter.		★					
Change the transmission fluid.		★					
Replace the fuel filters.		★					
Check the steering system and remote control for loose, missing or damaged parts. Lubricate the cables and linkages.		★					
Retorque the engine mounts.				★			
Check the spark plugs, wires, and distributor cap.				★			
Clean the flame arrestor and the crankcase ventilation hoses. Replace the PCV valve.				★			
Check the electrical system for loose, damaged or corroded fasteners.				★			
Inspect the condition and tension of the belts.				★			

* Only perform maintenance which applies to your particular power package

◆ Whichever occurs first

Gas Inboard And Tow Sports (continued)

Scheduled Maintenance *	Annually	Every 100 hours or Annually ◆	Every 200 hours or 3 years ◆	Every 300 hours or 3 years ◆	Every 2 years	Every 5 years	Per OEM
Check the cooling system and exhaust system hose clamps for tightness. Inspect both systems for damage or leaks.				★			
Disassemble and inspect the seawater pump and replace worn components.				★			
Clean the seawater section of the closed cooling system. Clean, inspect and test the pressure cap.				★			
Replace the coolant.					♠	★	
Check the engine to propeller shaft alignment.							★

* Only perform maintenance which applies to your particular power package

◆ Whichever occurs first

♠ Interval will be reduced if not using extended life coolant

Crankcase Oil

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-cycle 25W40 Engine Oil. This oil is a special blend of 25-weight and 40-weight oils for marine engines. If not available, a good grade, straight weight, detergent automotive oil of the correct viscosity, with an API classification of SH, CF/CF-2, may be used.

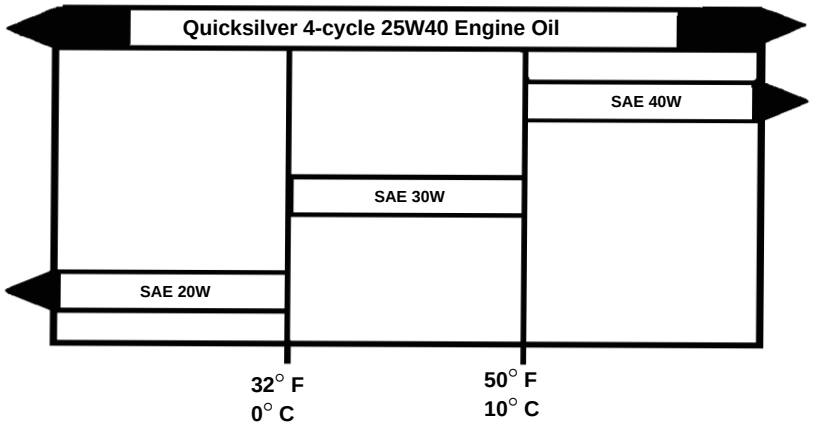
In those areas where Quicksilver 4-cycle 25W40 Engine Oil or a recommended straight weight oil are not available, a multi-viscosity 20W40 or, as a second but less preferable choice, 20W50, with API service ratings of SH, CF/CF-2 may be used.

IMPORTANT: The use of non-detergent oils, multi-viscosity oils (other than Quicksilver 25W40 or a good quality 20W40 or 20W50), synthetic oils, low quality oils or oils that contain solid additives are specifically not recommended.

The chart below is a guide to crankcase oil selection. The oil filter should always be changed when changing the engine oil.

⚠ CAUTION

Mercury or Quicksilver 4-cycle 25W40 engine oil is recommended for use for your engine. Severe engine damage may result from the use of an inferior oil.



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Overfilled Crankcase Oil

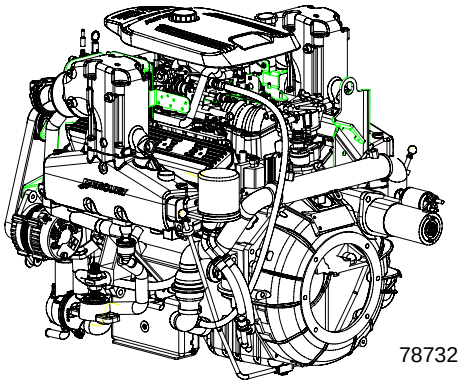
An overfilled crankcase (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm clatter on Mercury MerCruiser engines. This condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to bleed down. This, in turn, results in rocker arm clatter and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking the engine oil level. The oil level must be maintained between the ADD mark and the FULL or OK RANGE mark on the dipstick. To ensure that you are not getting a false reading, ensure the following:

- Boat at rest in the water, or
- If the boat is on a trailer, raise or lower the bow until the boat is setting at the approximate angle that it would be if setting at rest in the water.
- Allow sufficient time for the oil to drain into the crankcase if the engine has just been operated or oil has just been added.

Checking

1. Stop the engine. Allow approximately 5 minutes for the oil to drain into the oil pan. The boat must be at rest in the water.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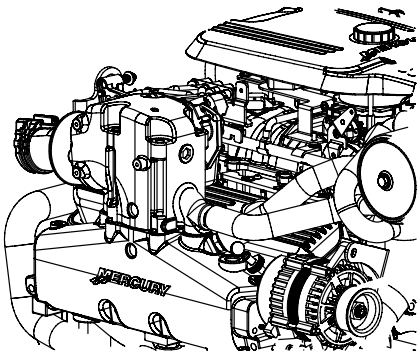
Typical Inboard and Tow Sports models



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Typical Sterndrive models

2. Remove the dipstick. Wipe it clean and reinstall it fully into the dipstick tube.
3. Remove the dipstick and observe the oil level. The oil level must be between the FULL or OK RANGE and ADD marks. Fill as necessary with the specified fluid.

MPI models	Capacity liters (U.S. qt)	Fluid type
Engine Oil (with filter)[1]	5.20 (5-1/2)	4-Cycle 25W40 Engine Oil

Carbureted models	Capacity liters (U.S. qt)	Fluid type
Engine Oil (with filter)[1]	4.7 (5)	4-Cycle 25W40 Engine Oil

[1] *Always use dipstick to determine exact quantity of oil or fluid required.*

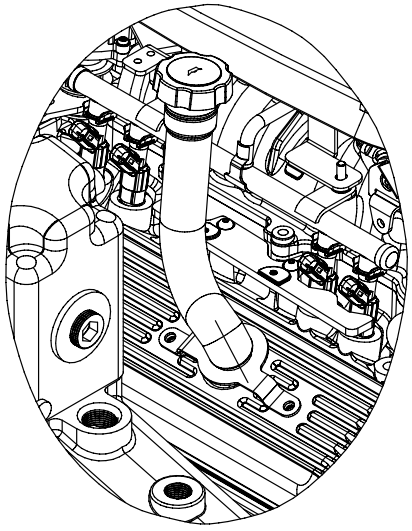
Filling

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

IMPORTANT: Do not overfill the crankcase with oil.

1. Remove the oil fill cap.



77842

MIE shown, MCM similar

2. Add the specified oil to bring the level up to, but not over the FULL or OK RANGE mark on the dipstick.

MPI models	Capacity liters (U.S. qt)	Fluid type
Engine Oil (with filter)[1]	5.20 (5-1/2)	4-Cycle 25W40 Engine Oil

Carbureted models	Capacity liters (U.S. qt)	Fluid type
Engine Oil (with filter)[1]	4.7 (5)	4-Cycle 25W40 Engine Oil

[1] *Always use dipstick to determine exact quantity of oil or fluid required.*

Changing Oil and Filter

Refer to the Maintenance schedule for the change interval. The crankcase oil should be changed before placing the boat in storage.

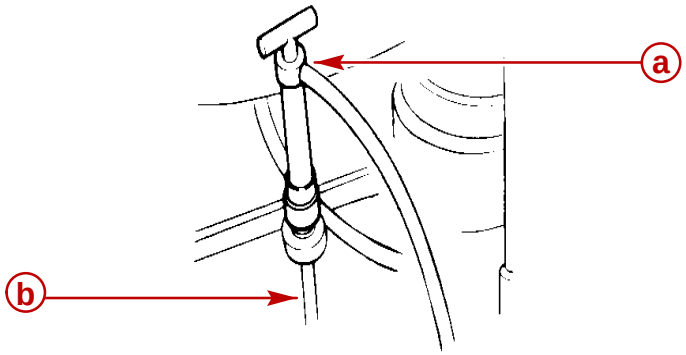
IMPORTANT: Change the crankcase oil when the engine is warm from operation. Warm oil flows more freely, carrying away more impurities. Use only the recommended engine oil (refer to Specifications).

QUICK DRAIN OIL

1. Pull the tether through the bilge drain.
2. Place the oil drain hose in a suitable container.
3. Remove the drain plug from the oil drain hose.
4. After the oil has drained completely, install the drain plug in the oil drain hose.
5. Push the hose through the bilge drain and install the plug.
6. Proceed to ALL MODELS.

CRANKCASE OIL PUMP

1. Remove the dipstick.
2. Insert the hose end of the crankcase oil pump onto an appropriate container and using the handle, pump until the crankcase is empty.



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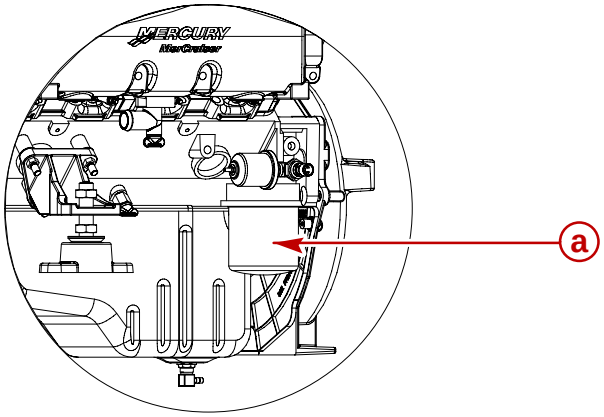
a - Crankcase oil pump
b - Dipstick tube

3. Remove the pump.
4. Install the dipstick.
5. Proceed to ALL MODELS.

ALL MODELS

1. Remove and discard the oil filter.



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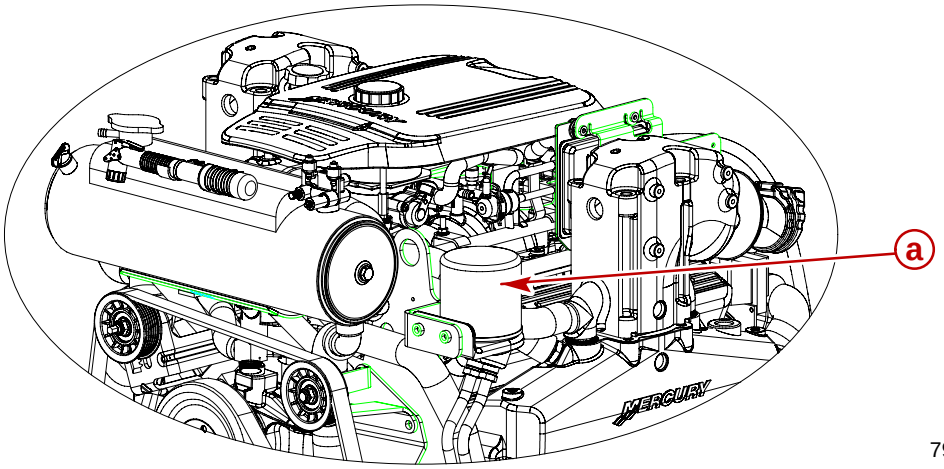
Carbureted Models

a - Oil filter

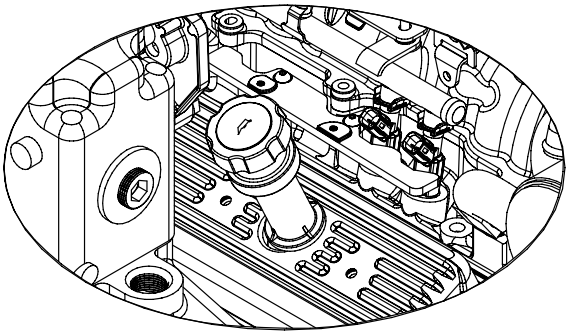


79364

MPI Models

a - Oil filter

2. Coat the sealing ring on the new filter with engine oil and install.
3. Tighten the filter securely (following filter manufacturer's instructions). Do not overtighten.
4. Remove the oil fill cap.



77843

MCM shown, MIE similar

IMPORTANT: Always use the dipstick to determine exactly how much oil is required.

5. Add the recommended engine oil to bring the level up to, but not over, the FULL or OK RANGE mark on the dipstick.

MPI models	Capacity liters (U.S. qt)	Fluid type
Engine Oil (with filter)[1]	5.20 (5-1/2)	4-Cycle 25W40 Engine Oil

Carbureted models	Capacity liters (U.S. qt)	Fluid type
Engine Oil (with filter)[1]	4.7 (5)	4-Cycle 25W40 Engine Oil

[1] *Always use dipstick to determine exact quantity of oil or fluid required.*

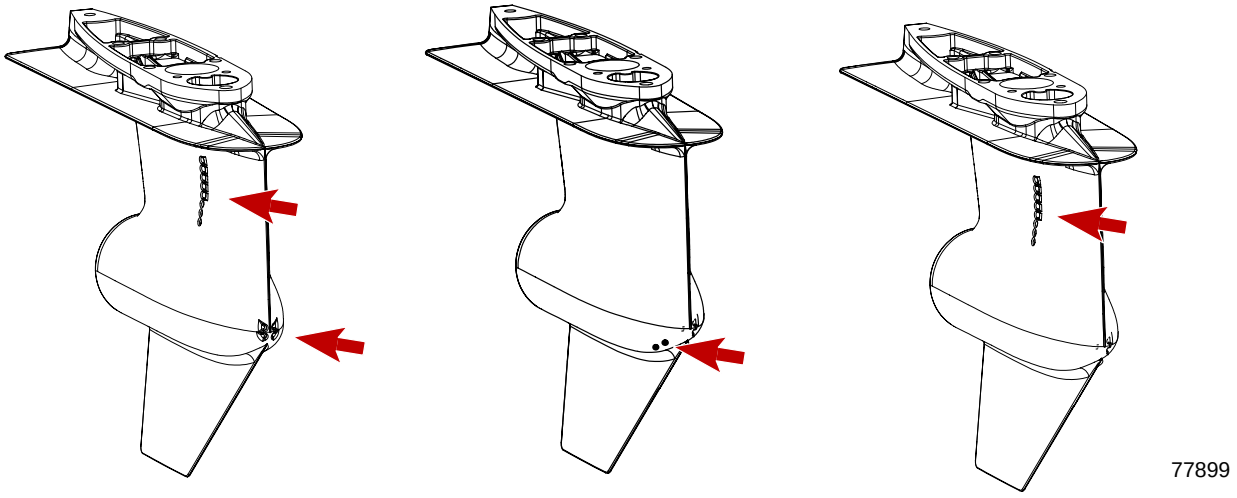
6. Start the engine and check for leaks.

Flushing The Power Package - MCM

Your boat could come equipped with 1 of 3 different types of water pickups: through the hull, through the transom and through the sterndrive. The flushing procedures for these systems are separated into 2 categories: sterndrive water pickups and alternative water pickups.

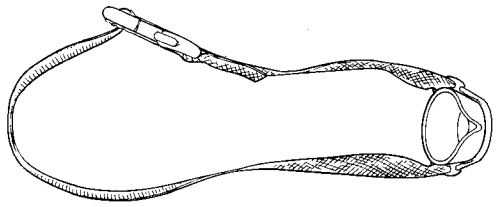
Sterndrive Water Pickups

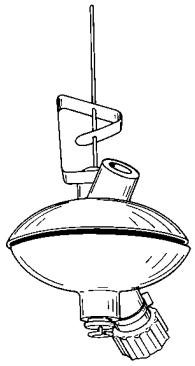
There are 3 types of water pickups available on Mercury MerCruiser sterndrives: low water, dual water, and side pickups. Dual water pickups require the flushing device (44357Q2) and the seal kit (881150Q1), low water pickups require the flushing attachment (849996T1) and side pickups require the flushing attachment (44357Q2).

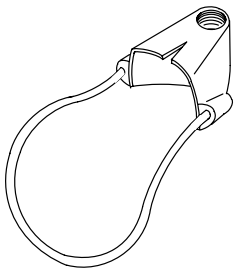


Dual water pickup **Low water pickup** **Side pickup**

FLUSHING ATTACHMENTS

Dual Water Pick-Up Flush Gear Case Seal Kit	91-881150Q1
Description: Use to block off the front water inlet holes on the dual water inlet gear cases.	 77977

Flushing Device	91-44357Q2
Description: Attaches to the drive unit water intakes, provides a fresh water connection when flushing the cooling system or operating the engine.	 73440

Flushing Kit	91-849996T1
Description: Use for flushing drives with low water inlet gear cases.	 78135

NOTE: *Flushing is needed only for salty, brackish, mineral laden, or polluted water applications. Flushing is recommended after each outing for best results.*

⚠ CAUTION

If flushing with the boat in the water, seawater can flow into the engine causing engine damage. Water inlet must be closed when flushing the engine.

1. Drain the seawater section of the cooling system.
2. If flushing cooling system with the boat in the water:
   a. Raise the sterndrive unit to the TRAILER position.
   b. Install the appropriate flushing attachment over the water intake openings in the gear housing.
   c. Lower the sterndrive unit to the full DOWN/IN position.
3. If flushing the cooling system with the boat out of the water:
   a. Lower the sterndrive unit to the full DOWN/IN position.

⚠ WARNING

Contact with moving drive components and the propeller can cause personal injury or death. To avoid possible injury, remove the propeller and ensure that no people or animals are in the area of the drive unit while flushing.

   b. Remove the propeller.
   c. Install the appropriate flushing attachment over the water intake openings in the gear housing.
4. Connect a hose between the flushing attachment and a water source.
5. With the sterndrive unit in normal operating position, partially open the water source (about 1/2 maximum).
6. Place the sterndrive in the NEUTRAL IDLE speed position and start the engine.

⚠ CAUTION

Suction created by the seawater pickup pump may collapse the flushing water hose causing the engine to overheat. Avoid engine damage from overheating; do not operate the engine above 1500 rpm.

7. Slowly advance the throttle until the engine reaches 1300 rpm (+/–100 rpm).

⚠ CAUTION

Engine overheating can cause engine damage. To avoid, observe the water temperature gauge and ensure that the engine is operating in the normal range.

8. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
9. Operate the engine with the sterndrive in NEUTRAL for about 10 minutes or until the discharge water is clear.
10. Slowly return the throttle to the idle speed position.
11. Stop the engine.
12. Shut off the water and remove the flushing attachment.

Alternative Water Pickups

IMPORTANT: Engines with the sterndrive water inlet blocked off at the gimbal housing and using a through the hull water inlet need a supply of cooling water available to both the sterndrive unit and to the engine during operation.

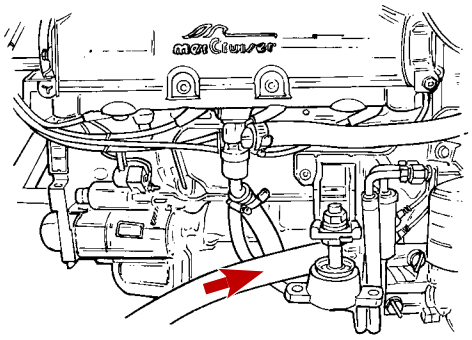
NOTE: *Flushing is needed only for salty, brackish, mineral laden, or polluted water applications. Flushing is recommended after each outing for best results.*

1. Drain the seawater section of the cooling system.
2. If flushing the cooling system with the boat in the water:
   a. Raise the sterndrive unit to the TRAILER position.
   b. Install the appropriate flushing attachment over the water intake openings in the gear housing.
   c. Lower the sterndrive unit to the full DOWN/IN position.
3. If flushing the cooling system with the boat out of the water:
   a. Lower the sterndrive unit to the full DOWN/IN position.

⚠ WARNING

Contact with moving drive components and the propeller can cause personal injury or death. To avoid possible injury, remove the propeller and ensure that no people or animals are in the area of the drive unit while flushing.

   b. Remove the propeller.
   c. Install the appropriate flushing attachment over the water intake openings in the gear housing.
4. Connect a hose between the flushing attachment and a water source.
5. Disconnect the water inlet hose (upper hose) from the aft side of the seawater pump.



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6. Using a suitable adapter, connect the flushing hose from the water source to the water inlet of the seawater pump.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

7. With sterndrive unit in normal operating position, partially open the 2 water sources (about 1/2 maximum).
8. Place sterndrive in NEUTRAL, IDLE speed position and start engine.

⚠ CAUTION

Suction created by the seawater pickup pump may collapse the flushing water hose causing the engine to overheat. Avoid engine damage from overheating; do not operate the engine above 1500 rpm.

9. Slowly advance throttle until engine reaches 1300 rpm (+/–100 rpm).

⚠ CAUTION

Engine overheating can cause engine damage. To avoid, observe the water temperature gauge and ensure that the engine is operating in the normal range.

10. Observe the water temperature gauge to ensure that the engine is operating in the normal range.
11. Operate the engine with the sterndrive in NEUTRAL for about 10 minutes or until the discharge water is clear.
12. Slowly return the throttle to the idle speed position.
13. Stop the engine.
14. Shut off the water and remove the flushing attachments.
15. Install the water inlet hose to the aft side of the seawater pump.
16. Tighten the hose clamp securely.

Flushing The Power Package - MIE

Precautions

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at the water inlet during engine operation.

⚠ CAUTION

If flushing with the boat in the water, seawater can flow into the engine causing engine damage. Water inlet must be closed when flushing the engine.

⚠ CAUTION

If boat is in the water, do not open water inlet valve until engine is to be restarted to prevent contaminated water from flowing back into engine.

⚠ CAUTION

Engine overheating can cause engine damage. To avoid, observe the water temperature gauge and ensure the engine is operating in the normal range.

Models Equipped With Engine Mounted Flush Attachment

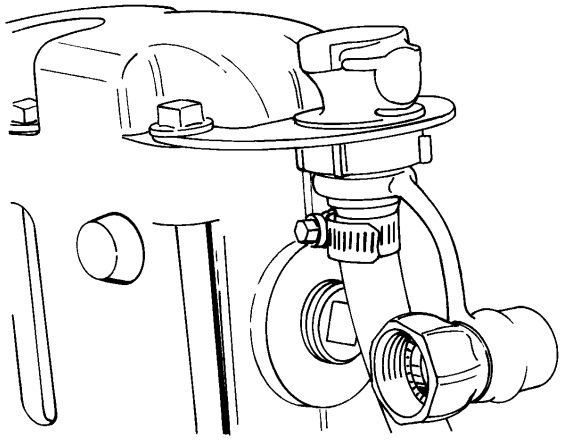
NOTE: *Flushing is needed only for salty, brackish, mineral laden, or polluted water applications. Flushing is recommended after each outing for best results.*

1. Close the water inlet valve or remove the water inlet hose and plug the inlet.
2. Drain the seawater from the engine.
3. Attach the quick connect fitting to a water hose.
4. Open the water source completely.
5. Remove the blue cap from the flush socket on the engine.

⚠ CAUTION

Do not let water flow for more than 15 seconds with engine not operating or too much flushing water will collect in the muffler causing engine damage.

6. Snap the quick connect fitting and the water hose into the flush socket on the engine.



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Horizon models

7. Start the engine within 15 seconds.
8. Operate the engine between 600 rpm and 800 rpm. Do not exceed 800 rpm.
9. Allow engine to reach normal operating temperature. Watch the temperature gauge on the dash to ensure that the engine does not overheat.
10. Flush the engine for 10 minutes or until discharge water is clear.
11. Shut off the engine.

⚠ CAUTION

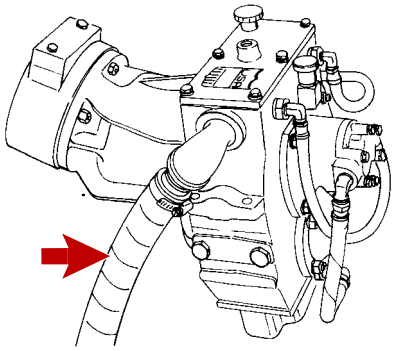
Do not let water flow for more than 15 seconds with engine not operating or too much flushing water will collect in the muffler causing engine damage.

12. Within 15 seconds, disconnect the quick connect fitting and water hose from the flush socket on the engine by pressing the release button on the flush socket.
13. Attach to the next engine, if equipped, and repeat procedure.
14. Turn off the water source.
15. Remove the quick connect fitting from the water hose.
16. Replace the blue cap into the flush socket on the engine.
17. Open the water inlet valve.

All Other Models

NOTE: *Flushing is needed only for salty, brackish, mineral laden, or polluted water applications. Flushing is recommended after each outing for best results.*

1. **If flushing the engine with the boat in the water**, close the water inlet valve or remove and plug the water inlet hose.
   a. **Models with Walter V-Drive Transmissions:** Disconnect water inlet hose from the transmission fitting. Using an appropriate connector, connect water hose to water source. Proceed to Step 3.



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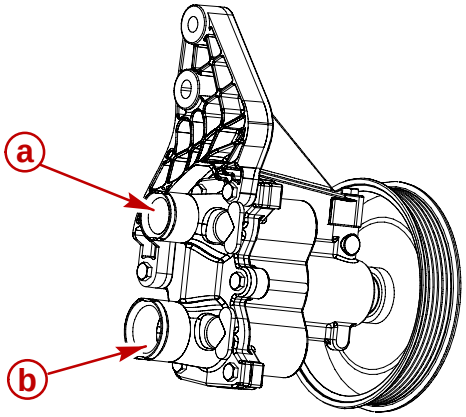
   b. **All other models:** Using an appropriate connector, connect the flushing hose from the water supply to the water inlet hose of the seawater pickup pump. Proceed to Step 3.



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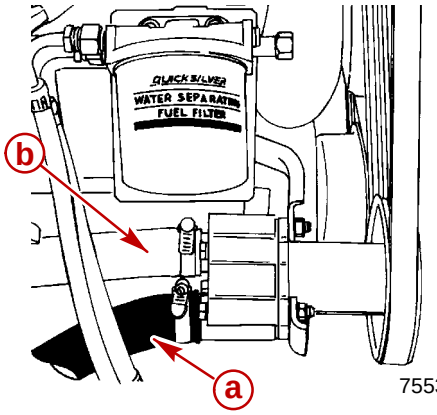


75533

All MPI models and carbureted closed cooled models

All other models

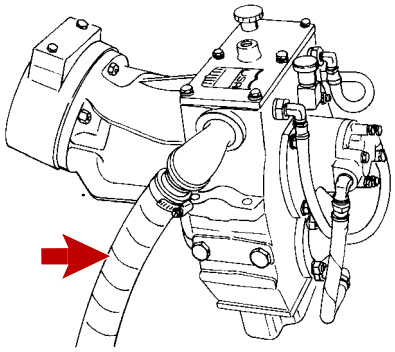
a - Seawater inlet hose
b - Hose to cooler

⚠ WARNING

Contact with moving drive components and the propeller can cause personal injury or death. To avoid possible injury, remove the propeller and ensure that no people or animals are in the propeller area while flushing.

2. **If flushing the engine with the boat out of the water**, remove the propeller. Refer to boat manufacturers' instructions.

   a. **Models with Walter V-Drive Transmissions:** Disconnect water inlet hose from transmission fitting. Using an appropriate connector, connect the flushing hose. Proceed to Step 3.



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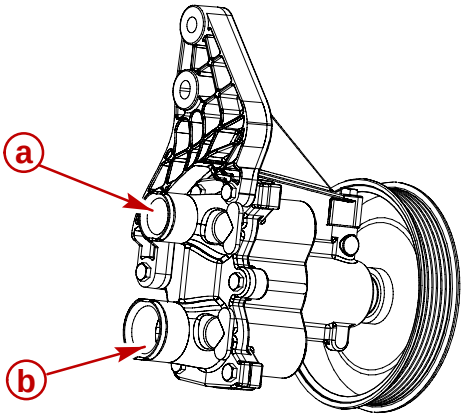
   b. **All other models:** Using an appropriate connector, connect the flushing hose from the water supply to the water inlet hose of the seawater pickup pump. Proceed to Step 3.



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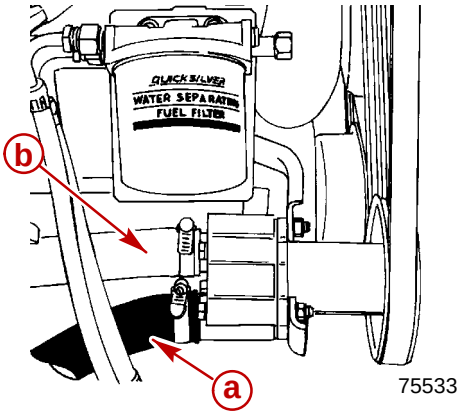


75533

All MPI models and carbureted closed cooled models

All other models

a - Seawater inlet hose
b - Hose to cooler

3. Open the water source.
4. Place remote control in NEUTRAL, idle speed position and start engine. Operate engine at idle speed, in NEUTRAL, for about 10 minutes or until discharge water is clear.
5. Stop the engine.
6. Remove the flushing connector from the water inlet.
7. Reconnect the water inlet hose.
8. Tighten hose clamp securely.
9. Attach to the next engine, if equipped, and repeat procedure.
10. Turn off the water source.
11. Open the water inlet or remove the plug from the water inlet fitting, and install the water inlet hose.
12. Replace the propeller, if removed. Refer to the boat manufacturer's instructions.

Transmission Fluid

⚠ WARNING

Do not remove the dipstick with the engine operating. Hot oil can cause burns.

⚠ CAUTION

Clean around the area of the dipstick before removing. Small particles of dirt can cause damage to internal components and cause the valves to stick.

Checking

WARM

IMPORTANT: Operate the engine at 1500 rpm for 2 minutes immediately prior to checking level.

IMPORTANT: Be sure to push the dipstick all the way down into the dipstick tube when checking fluid level.

1. Velvet Drive Transmissions:

NOTE: *Checking the transmission fluid level while warm requires 2 people as the level begins to rise within 2 seconds of stopping the engine. For convenience and to ensure accurate readings, it is recommended that a cold fluid full mark is made and the cold fluid procedure is followed.*

   a. Loosen the dipstick by turning the T-handle COUNTERCLOCKWISE until it moves freely within the dipstick tube. Leave the handle inserted fully in the dipstick tube.
   b. Start the engine and operate in NEUTRAL at 1500 rpm for 2 minutes.
   c. Stop the engine.
   d. Immediately remove the dipstick and wipe it clean.

IMPORTANT: Push the dipstick all the way down into the dipstick tube when checking fluid level.

e. Insert the dipstick fully into the transmission, withdraw it, and read the fluid level. Fluid level should be up to full mark. If low, add specified fluid through dipstick tube on transmissions.

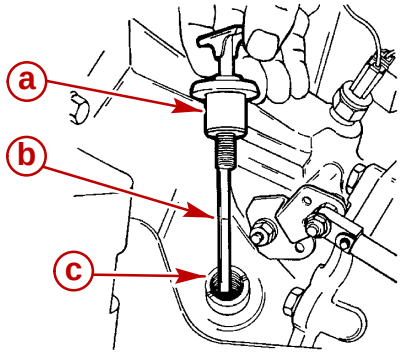
(1.) Allow approximately 15 seconds for the fluid to settle; insert the dipstick.

(2.) Start the engine and operate for 60 seconds. Shut engine off.

(3.) Repeat steps b.-e. until correct fluid level is obtained.

2. ZF Marine Transmissions - Stop engine and remove dipstick to check level. If fluid is below top (full) line, add specified fluid through dipstick hole. Do not overfill. Reinstall dipstick with cap fully seated.

3. Walter V-Drive Transmissions - Stop engine and remove dipstick to check level. If fluid is below top (full) line, add specified fluid through breather elbow. Do not overfill. Reinstall dipstick with cap fully seated.



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Typical

a - Dipstick
b - Full mark
c - Dipstick tube

COLD

NOTE: Cold Fluid Level Check: *To ease checking the fluid level, the dipstick can be marked or scribed with a cold level mark.*

1. Follow the procedure for the warm fluid level check to ensure the transmission is full and then allow the boat to sit overnight.

IMPORTANT: Be sure to push the dipstick all the way down into the dipstick tube when checking the fluid level.

2. Remove the dipstick, wipe clean, and reinsert.
3. Remove the dipstick, observe the fluid level, and mark the cold fluid level.
4. Reinstall the dipstick and tighten the T-handle securely. Do not overtighten.
5. Future checks can be made when the transmission fluid is cold:

   a. Remove the dipstick and wipe it clean.

   b. Reinsert the dipstick and remove to observe the fluid level.

Changing and Filling

Refer to **Section 8** for the procedures on changing and filling the transmission.

Sterndrive Unit Oil

Checking

NOTE: *Oil level will fluctuate during operation. The oil level should be checked with a cold engine before starting.*

1. Check the gear lube monitor oil level. Keep the oil level at or near the “OPERATING RANGE” line.
2. If any water is visible at the bottom of the monitor or appears at the oil fill/drain plug and/or if the oil appears discolored, immediately determine the cause and correct. Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual. Both conditions may indicate a water leak somewhere in the sterndrive unit.

Filling

IMPORTANT: If more than 59 ml (2 fl. oz.) of fluid is required to fill the monitor, a seal may be leaking. Damage to the sterndrive unit may occur due to lack of lubrication.

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

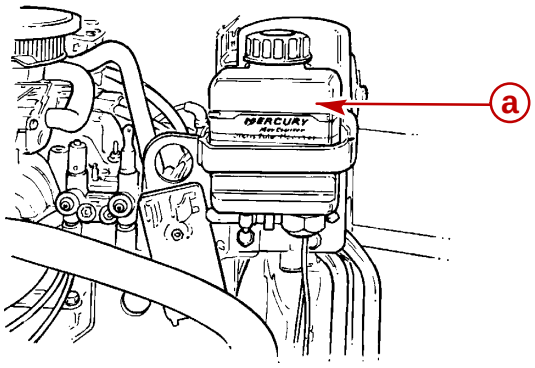
1. Remove the gear lube monitor cap.
2. Fill to the OPERATING RANGE line.

Model	Capacity Liters (U.S. qts)	Fluid Type
Alpha One	1.89 (2)	High Performance Gear Lube
Bravo One	2.60 (2.75)	
Bravo Two	3.08 (3.26)	
Bravo Three	2.84 (3)	

3. Replace the cap.

Changing

1. Remove the gear lube monitor from the bracket.



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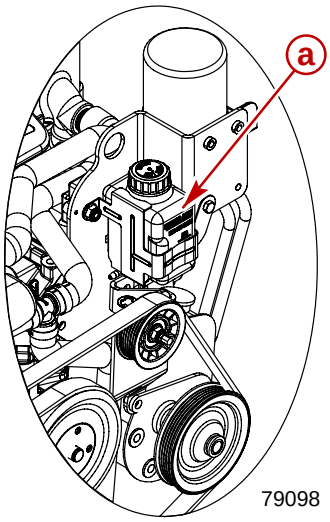
0M639999 and below MPI shown, carbureted models similar

a - Gear lube monitor



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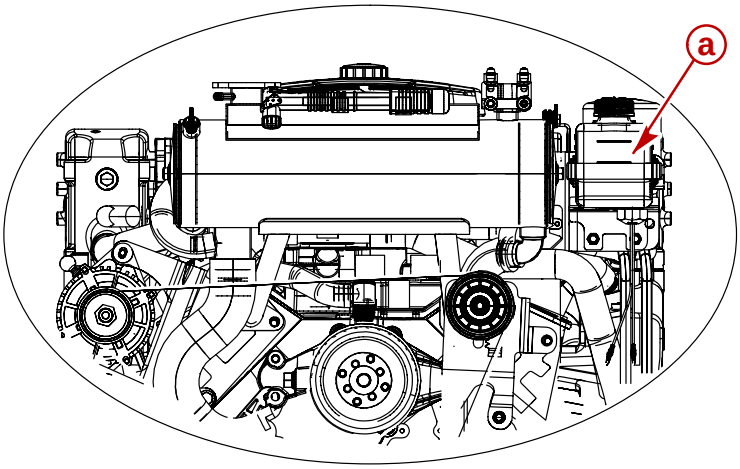
0M640000 and above seawater cooled models

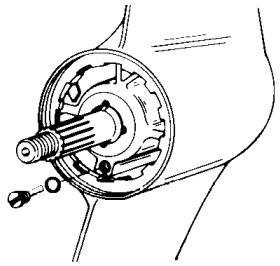


0M640000 and above closed cooled models

a - Gear lube monitor

2. Empty into a suitable container.
3. Install the monitor in the bracket.

4. **Bravo One Models:**
   a. Remove the propeller.
   b. Place the sterndrive unit in the full trim limit IN position.
   c. Remove the oil fill/drain screw and the sealing washer; drain the oil.



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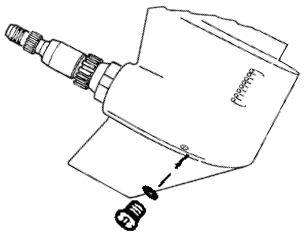
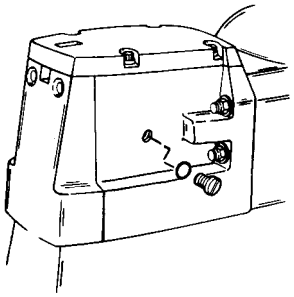
5. **All Other Models:**
   a. Place the sterndrive unit in the full trim limit OUT position.
   b. Remove the oil fill/drain screw and the sealing washer; drain the oil.



72522

IMPORTANT: If any water drained from the oil fill/drain hole, or if the oil appears milky, the sterndrive unit is leaking and should be checked immediately.

6. Remove the oil vent screw and the sealing washer. Allow the oil to drain completely.



77106

7. Lower the sterndrive unit until the propeller shaft is level.

IMPORTANT: Use only specified oil in the sterndrive unit.

8. Fill the sterndrive unit, through the oil fill/drain hole, with the specified oil until an air free stream of oil flows from the oil vent hole.

Description	Where Used	Part Number
Premium Gear Lubricant	Sterndrive unit	92-802846A1

9. Install the oil vent screw and the sealing washer.
10. Continue to pump the oil into the gear lube monitor circuit until the oil appears in the gear lube monitor. Fill the monitor to the “OPERATING RANGE” line.
11. Ensure that the rubber gasket is inside the cap and install the cap. Do not overtighten.
12. Remove the pump from the oil fill/drain hole. Quickly install the sealing washer and the oil fill/drain screw. Tighten securely.
13. **Bravo One and Alpha Models**: Grease the propeller shaft heavily, with the specified lubricant. Reinstall the propeller and torque the nut.
14. **Bravo Two Models**: Grease the propeller shaft heavily, with the specified lubricant. Reinstall the propeller and torque the nut.

Description	Where Used	Part Number
Special Lubricant 101	Propeller shaft	92-802865A-1

Description	Nm	lb-in.	lb-ft
Single propeller nut[1]	75		55
	Then align tabs with grooves.		

[1] Amount specified is MINIMUM.

Bravo Three

REMOVAL

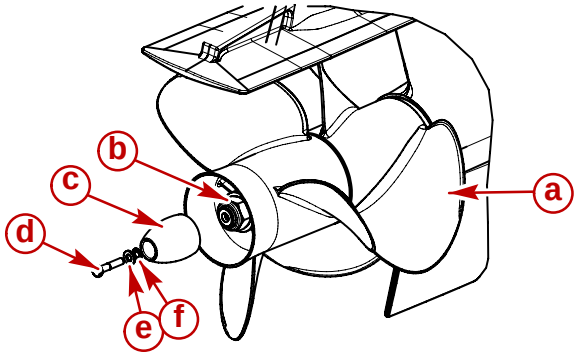
⚠ WARNING

Avoid Injury: Remote Control must be in NEUTRAL and ignition key removed from switch before removing and/or installing propeller.

⚠ WARNING

Avoid Injury: Place a block of wood between anti-ventilation plate and propeller to protect hands from propeller blades and to prevent propeller from rotating when removing propeller nut.

1. Place wood block between propeller blades and anti-ventilation plate to prevent rotation.
2. Remove the bolt and washers securing the propeller nut anode.
3. Remove the propeller nut anode.



79161

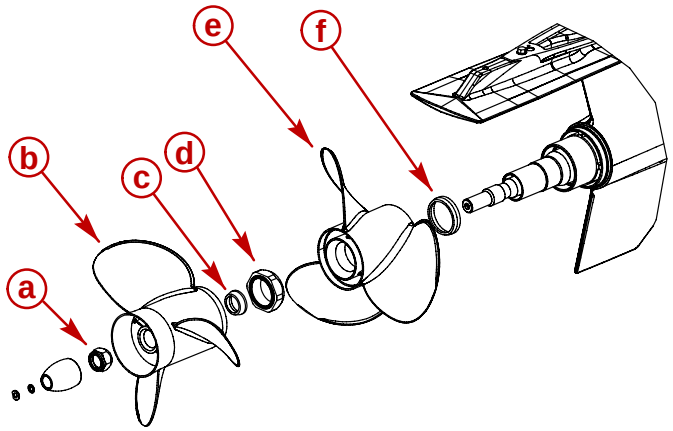
a - Propeller
b - Propeller shaft nut
c - Propeller shaft anode
d - Propeller shaft anode screw
e - Flat washer
f - Star washer

4. Turn aft propeller shaft nut (1-7/16 in. or 37 mm) COUNTERCLOCKWISE to remove nut.
5. Slide propeller and thrust hub off propeller shaft.
6. Turn front propeller shaft nut (2-3/4 in. or 70 mm) COUNTERCLOCKWISE to remove nut.
7. Slide propeller and thrust hub off propeller shaft.

REPAIR

Some damaged propellers can be repaired. Contact your authorized Mercury MerCruiser dealer.

INSTALLATION



77107

a - Rear propeller nut
b - Rear propeller
c - Rear propeller thrust hub
d - Front propeller nut
e - Front propeller
f - Front propeller thrust hub

1. Apply a liberal coat of one of the following lubricants to the propeller shaft.

Description	Where Used	Part Number
Anti-Corrosion Grease	Propeller shaft	92-802867A1
Special Lubricant 101		92-802865A1
2-4-C with Teflon		92-802859A1

2. Slide forward thrust hub onto propeller shaft with tapered side toward propeller hub (toward end of shaft).
3. Align splines and place propeller on propeller shaft.
4. Install and torque the propeller nut. Check propeller at least every 20 hours of operation and retorque as needed.

Description	Nm	lb-in.	lb-ft
Front dual propeller nut[1]	136		100

[1] *Amount specified is MINIMUM.*

5. Slide aft thrust hub onto propeller shaft with tapered side toward propeller hub (toward end of shaft).
6. Align splines and place propeller on propeller shaft.

⚠ CAUTION

Avoid Injury: Periodically check propeller nut for tightness during boating season. A minimum of 60 lb-ft (81 Nm) torque is required.

7. Install and torque the propeller nut. Check propeller at least every 20 hours of operation and retorque as needed.

Description	Nm	lb-in.	lb-ft
Rear dual propeller nut[1]	81		60

[1] *Amount specified is MINIMUM.*

8. Install the propeller shaft anode over the propeller shaft nut.
9. Place the flat washer onto the propeller shaft anode screw.
10. Place the star washer onto the propeller shaft anode screw.

NOTE: *If the propeller shaft anode is removed after initial installation and is to be reinstalled, it will be necessary to apply Loctite 271 Threadlocker to the threads of the propeller shaft anode screw.*

11. Secure the propeller shaft anode to the propeller shaft using the propeller shaft anode screw and washers. Torque the screw.

Description	Nm	lb-in.	lb-ft
Propeller shaft anode screw 5/16-18 x 1-1/2 in. (38 mm) long	27		20

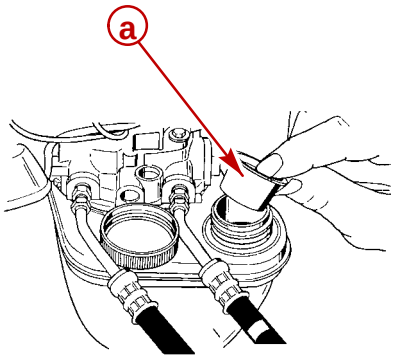
12. Recheck the oil level after first use.

IMPORTANT: The oil level in the gear lube monitor will rise and fall during drive operation; always check the oil level when the drive is cool and the engine is off.

Power Trim Pump Fluid

Checking

1. Place the sterndrive unit in the full DOWN/IN position.



70979

a - Cap plug

2. Remove the fill cap from the reservoir and observe the oil level. The level must be up to, but not over the bottom of the filler neck.
   a. Ensure that the cap plug has been removed from the filler neck and discarded.

NOTE: *The fill cap is vented.*

3. Fill as necessary with specified fluid.

Filling

1. Remove the fill cap from the reservoir.
2. Add fluid to bring the level to the bottom of the filler neck.

Description	Where Used	Part Number
Power Trim and Steering Fluid or SAE 10W-30 Engine Oil	Power Trim Pump	92-802880Q1

3. Replace the cap.

Changing

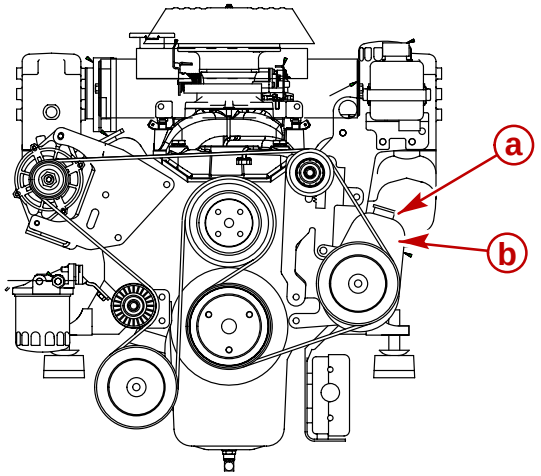
Power Trim fluid does not require changing.

Power Steering Pump Fluid

Checking

ENGINE WARM

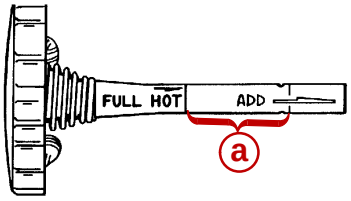
1. Stop the engine. Center the sterndrive unit.
2. Remove the fill cap / dipstick from the power steering pump and note the fluid level.



77108

a - Fill cap / dipstick
b - Power steering pump

3. The level should be between the “FULL HOT” mark and the “ADD” mark on the dipstick.



72518

a - Proper fluid level with engine warm

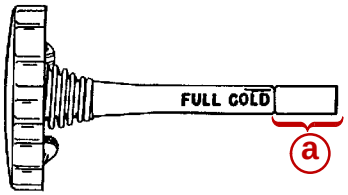
4. If the level is below the “ADD” mark, but fluid is still visible in the pump reservoir, add the required amount of fluid through the fill cap opening to bring the level up to the “FULL HOT” mark on the dipstick. Do not overfill.

Description	Where Used	Part Number
Power Trim and Steering Fluid or Dexron III Automatic Transmission Fluid	Power Steering System	92-802880Q1

5. If fluid is not visible in the reservoir, a leak exists in the power steering system. Find the cause and correct.

ENGINE COLD

1. With the engine stopped, center the sterndrive unit.
2. Remove the fill cap / dipstick from the power steering pump and note the fluid level.
3. The level should be between the FULL COLD mark and the bottom of the dipstick.



72519

a - Proper fluid level with engine cold

4. If the level is below the bottom of the dipstick, but fluid is still visible in the pump reservoir, add the required amount of specified fluid through the fill cap opening to bring the level up to the “FULL COLD” mark on the dipstick. Do not overfill.
5. If fluid is not visible in the reservoir, a leak exists in the power steering system. Find the cause and correct.

Filling and Bleeding

IMPORTANT: The power steering system must be filled exactly as explained to ensure that all air is bled from the system. All air must be removed or fluid in the pump may foam during operation and be discharged from the pump reservoir. Foamy fluid may also cause the power steering system to become spongy, which may result in poor boat control.

1. With the engine stopped, center the sterndrive unit.
2. Remove the fill cap / dipstick from the power steering pump.

IMPORTANT: Use only specified fluid in the power steering system.

3. Add specified fluid, as required, to bring the level up to the FULL COLD mark on the dipstick.
4. Turn the steering wheel back and forth to the end of travel in each direction several times.
5. Recheck the fluid level and add fluid, if necessary.
6. Install the vented fill cap. Tighten securely.

⚠ CAUTION

Do not operate engine without water being supplied to seawater pickup pump or pump impeller may be damaged and subsequent overheating damage to engine may result.

7. Start the engine and operate at fast idle (1300 rpm) until the engine reaches normal operating temperature. During this time, turn the steering wheel back and forth to the end of travel in each direction several times.
8. Center the sterndrive unit and stop the engine.
9. Remove the fill cap from the pump.
10. Allow any foam in the pump reservoir to disperse.
11. Check the fluid level and add fluid, as required, to bring the level up to the FULL HOT mark on the dipstick. Do not overfill**.**
12. Reinstall the fill cap. Tighten securely.

IMPORTANT: The drive unit must be centered and the power steering fluid must be hot to accurately check the fluid level.

13. If the fluid is still foamy (in Step 10.), repeat Steps 7. through 12. until the fluid does not foam and the level remains constant.

Water Inlets

All water inlets should be inspected for obstruction. Refer to the maintenance charts for the interval.

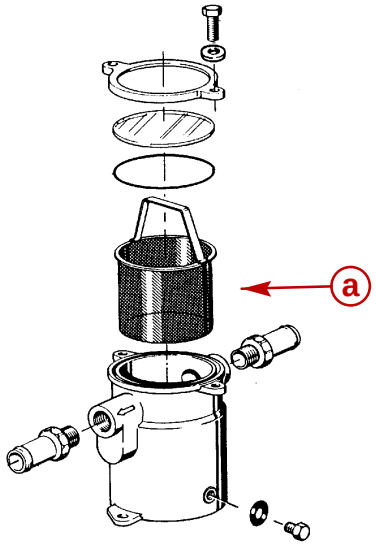
1. Remove debris or marine growth from all water inlets.
2. Flush with clean water.

Seawater Strainer

⚠ CAUTION

Ensure that boat is out of the water or seacock is closed and bilge pump is operating before beginning procedure. Excess water in bilge can damage engine or cause boat to sink.

1. Remove the seawater strainer.
2. Disassemble the components.
3. Clean the filter element.



72673

a - Filter element

4. Flush with clean water.
5. Reassemble the components.
6. Install the seawater strainer.

Closed Cooling System

Checking Coolant Level

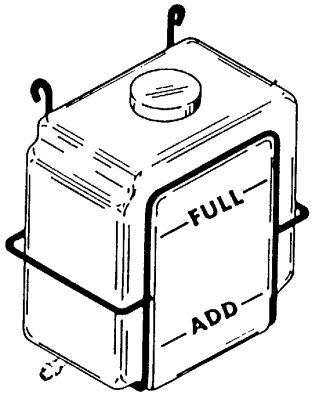
⚠ CAUTION

Allow the engine to cool down before removing the pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn to allow any pressure to escape slowly, then push down and turn the cap all the way off.

1. Remove the cap from the heat exchanger and observe the fluid level.
2. The coolant level in the heat exchanger should be at the bottom of the filler neck.

IMPORTANT: When reinstalling the pressure cap, tighten until it seats on the filler neck.

3. With the engine at normal operating temperature, check the coolant level in the coolant recovery bottle.
4. The coolant level should be between the “ADD” and “FULL” marks.



72520

5. Add the specified fluid as necessary.

Cleaning and Inspection

NOTE: *Refer to* ***Section 6C.***

1. Ensure that all hose clamps are tight and connections are secure.
2. Inspect the entire system for damage or leaks.
3. Clean the seawater section.
4. Clean, inspect and test the pressure cap.

Changing Coolant

The coolant should be changed periodically based on the use of the specified coolant; refer to the Maintenance Schedules for the interval. For the changing coolant procedures, refer to **Section 6C**.

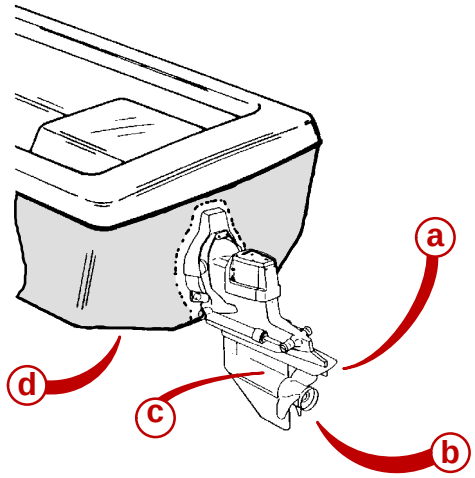
Anodes

NOTE: *Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual for propeller removal and installation.*

IMPORTANT: Replace the sacrificial anodes if eroded 50 percent or more.

Each sterndrive unit is equipped with a sacrificial anodic plate to help protect underwater metal parts from galvanic corrosion. Because of its self-sacrificing nature, the anodic plate MUST BE replaced if eroded 50 percent or more.

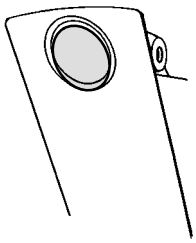
The sterndrive unit anodes should be inspected for erosion. Refer to the Maintenance Schedules for the interval.



71176

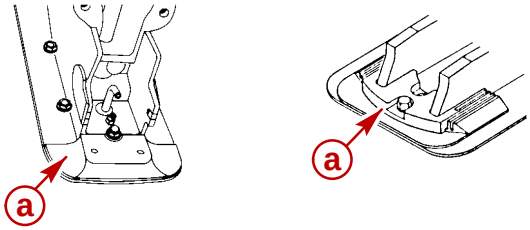
a - Universal anodic plate
b - Anodic plate
c - MerCathode (if equipped)
d - Anode kit (if equipped)

1. **Universal Anodic Plate -** Serves as a sacrificial anode.



73919

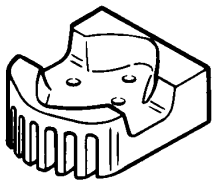
2. **Anodic Plate -** Serves as a sacrificial anode.



70575

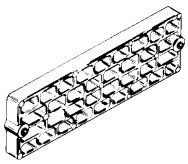
a - Anodic plate

3. **Block (if equipped) -** Mounted to the underside of the gimbal housing and serves as a sacrificial anode.



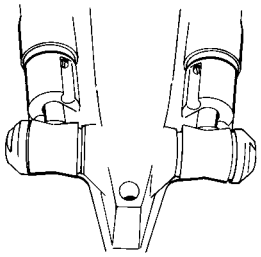
70576

4. **Anode Kit (if equipped) -** Mounted to the boat transom. Acts as a sacrificial anode.



70577

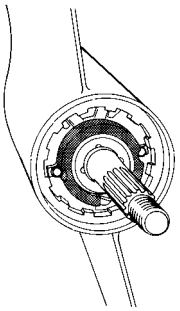
5. **Trim Cylinder Anodes -** Mounted on each trim cylinder. To replace the trim cylinder anodes:



71966

   a. Remove 2 screws from the anode.
   b. Clean the mounting surfaces down to the bare metal for proper contact.
   c. Install the new anode. Tighten the screws securely.

6. **Bearing Carrier Anode (Alpha and Bravo One) -** Located in front of the propeller, between the front side of the propeller and the gear housing. To replace the propeller anode:



72032

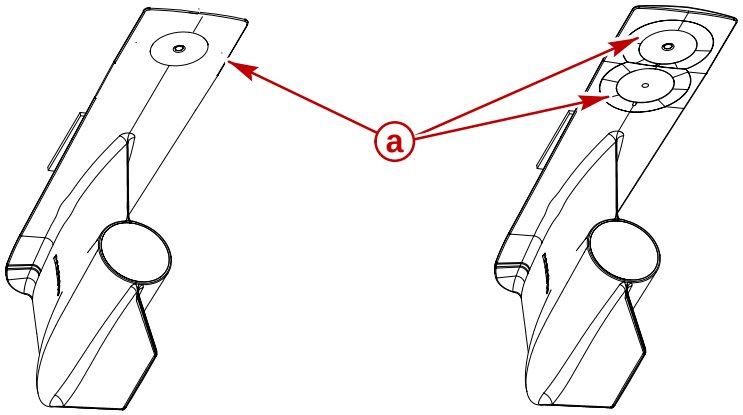
   a. Remove the propeller.
   b. Remove 2 screws from the anode.
   c. Clean the mounting surfaces down to the bare metal for proper contact.
   d. Install the new anode. Tighten the screws securely.
   e. Reinstall the propeller.

7. Torque the propeller nut. (Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual or Operation, Maintenance, and Warranty Manual for propeller removal and installation.)

Description	Nm	lb-in.	lb-ft
Single propeller nut[1]	75		55
	Then align tabs with grooves.		
Front dual propeller nut[1]	136		100
Rear dual propeller nut[1]	81		60

[1] *Amount specified is MINIMUM.*

Gearcase Anodic Plate - Is mounted on the underside of the lower gearcase and serves as a sacrificial anode.

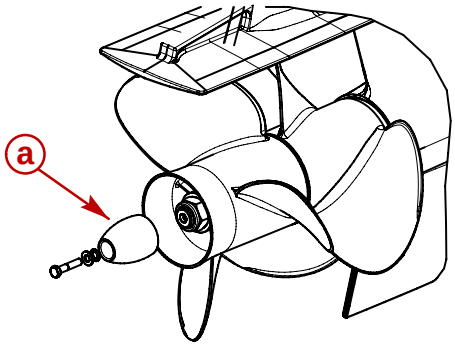


79285

Alpha, Bravo One, Brave Two Models **All Bravo Three Models**

a - Anode

Propshaft Anode (Bravo Three Only) - is located in front of the propeller, between the front side of the propeller and the gear housing.

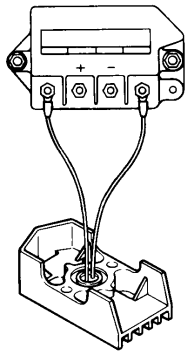


79161

a - Propshaft anode

In addition to the corrosion protection devices, the following steps should be taken to inhibit corrosion:

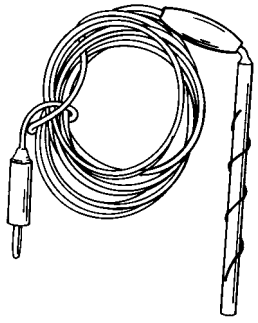
1. Paint your power package, refer to Painting Your Power Package.
2. Spray power package components on inside of boat annually with Corrosion Guard to protect finish from dulling and corrosion. External power package components may also be sprayed.
3. All lubrication points, especially steering system, shift and throttle linkages, should be kept well lubricated.
4. Flush cooling system periodically, preferably after each use.
5. **MerCathode System (if equipped) -** Electrode assembly replaces the Anodic block.



70578

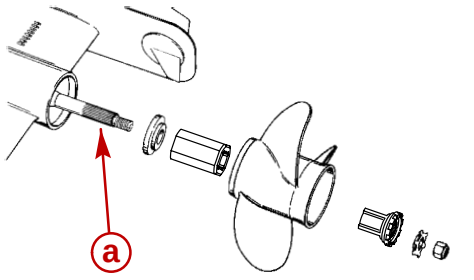
The system should be tested to ensure adequate output.

The test should be made where the boat is moored, using Quicksilver Reference Electrode and Test Meter.

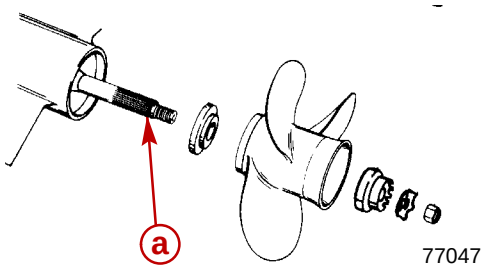
Reference Electrode		
 73446	Senses an electrical current in the water when testing the MerCathode system. Use to check hull potential.	91-76675T1

Propeller Shaft

1. Lubricate the propeller shaft splines.

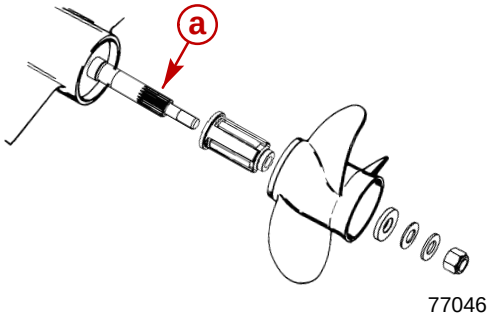


Alpha sterndrive

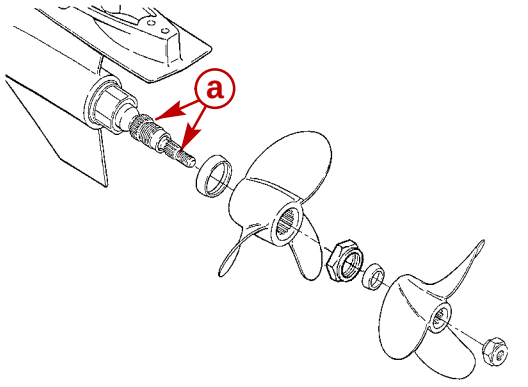


Bravo One sterndrive

a - Propeller shaft splines



Bravo Two sterndrive



Bravo Three sterndrive

a - Propeller shaft splines

2. Torque the propeller nut. (Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual or Operation, Maintenance, and Warranty Manual for propeller removal and installation.)

Description	Nm	lb-in.	lb-ft
Single propeller nut[1]	75		55
	Then align tabs with grooves.		
Front dual propeller nut[1]	136		100
Rear dual propeller nut[1]	81		60

[1] *Amount specified is MINIMUM.*

Power Package Surfaces (Saltwater Only)

The entire power package should be sprayed at recommended intervals with Corrosion Guard. Follow the instructions on the can for proper application.

NOTE: *If operating in saltwater, the interval for treating the engine surface with Corrosion Guard will be reduced. Refer to Maintenance Schedules.*

Description	Where Used	Part Number
Corrosion Guard Spray	Power package	92-802878 55

The entire power package should be cleaned and the external surfaces that have become bare should be repainted with Primer and Spray Paint at recommended intervals. Refer to Maintenance Schedules.

Painting Your Power Package

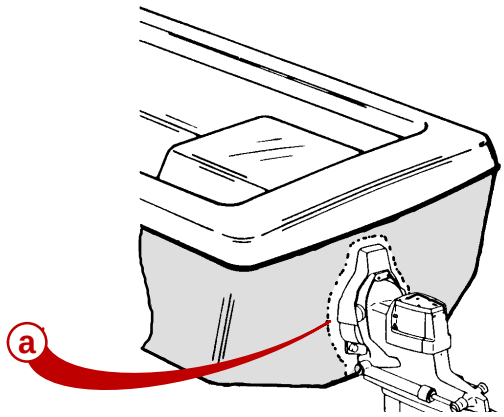
IMPORTANT: Corrosion damage that results from the improper application of anti-fouling paint will not be covered by the limited warranty.

1. **Painting the boat hull or the boat transom:** Anti-fouling paint may be applied to the boat hull and the boat transom but you must observe the following precautions:

IMPORTANT: Do not paint the anodes or the MerCathode System reference electrode and anode, as this will render them ineffective as galvanic corrosion inhibitors.

IMPORTANT: If anti-fouling protection is required for the boat hull or the boat transom, copper base paints, if not prohibited by law, can be used. If using copper based anti-fouling paints, observe the following:

- **Avoid any electrical interconnection between the Mercury MerCruiser Product, Anodic Blocks or MerCathode System and the paint by allowing a minimum of 40 mm (1-1/2 in.) UNPAINTED area on the transom of the boat around these items.**



71176

a - Minimum unpainted area

2. **Painting Drive Unit or Transom Assembly:** The drive unit and the transom assembly should be painted with a good quality marine paint or an anti-fouling paint that DOES NOT contain copper or any other material that could conduct an electrical current. Do not paint the drain holes, the anodes, the MerCathode system, and items specified by the boat manufacturer.

Battery

NOTE: *Refer to the manufacturer's instructions.*

1. Ensure that the battery connections are secure.
2. Check the fluid level.

Instruments

1. Ensure that the gauges are tight. Tighten the mounting bracket nuts, if loose. Do not overtighten.
2. Ensure that all gauge and wiring connections are tight and insulated where necessary.

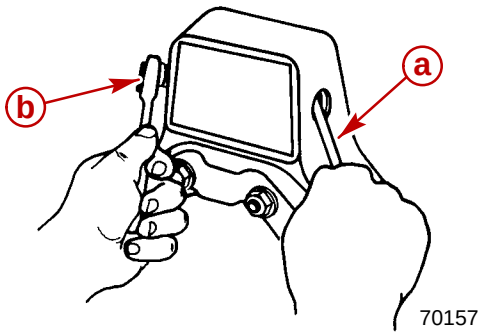
IMPORTANT: The gauge may be scored or damaged if wiped with abrasive material such as sand, saline or detergent compounds or washed with solvents such as trichlorethylene and turpentine.

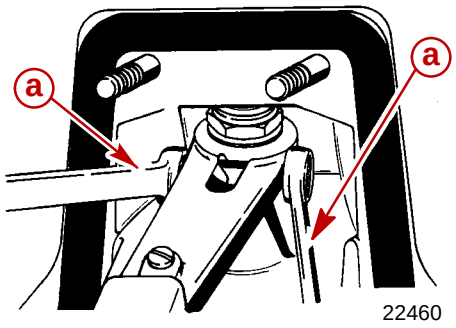
3. Clean the gauges with fresh water to remove sand and salt deposits. Wipe with a soft cloth moistened with water.

Gimbal Ring / Steering Connection

NOTE: *Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual for sterndrive removal and installation.*

1. Check the connection between the gimbal ring and the steering shaft.
2. Tighten the steering lever clamping bolt and nut.





Engine and transom assembly

Installed **Removed**

a - Wrench
b - Socket wrench

Description	Nm	lb-in.	lb-ft
Steering lever clamping bolt and nut	67.8		50

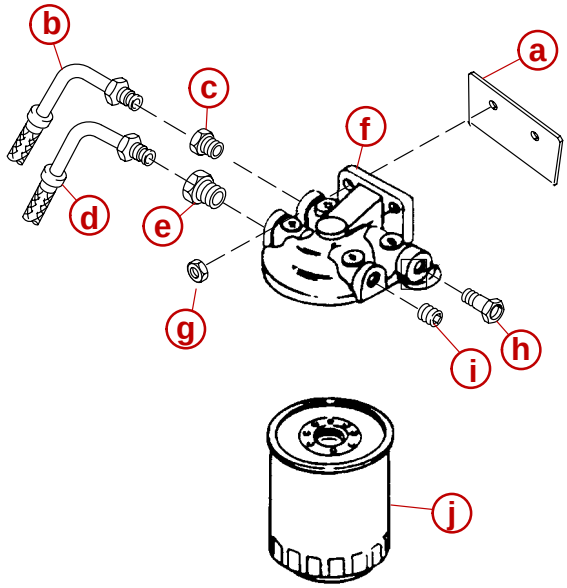
Changing Water Separating Fuel Filter

⚠ WARNING

Avoid Fire or Explosion: The fuel injection system is pressurized during operation. Use care when removing the water separating fuel filter. Fuel could spray on the hot engine causing fire or explosion. Allow the engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.

⚠ WARNING

Be careful when changing the water separating fuel filter. Gasoline is extremely flammable and highly explosive under certain conditions. Ensure the ignition key is OFF. Do not smoke or allow spark or open flame in the area when changing the fuel filter. Wipe up any spilled fuel immediately.



78131

a - Insulator plate
b - Fuel return line from regulator
c - Brass fitting
d - Fuel line to fuel pump
e - Brass Fitting
f - Fuel filter mounting bracket
g - Nut
h - Fuel inlet fitting
i - Plug
j - Water separating fuel filter

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Allow the engine to cool down.

NOTE: *Mercury MerCruiser recommends that the engine be shut off for 12 hours prior to filter removal.*

2. Disconnect both battery cables from the battery.
3. Activate the Schrader valve to relieve fuel pressure.

⚠ WARNING

Avoid Fire or Explosion: The fuel injection system is pressurized during operation. Use care when removing the water separating fuel filter. Fuel could spray on the hot engine causing fire or explosion. Allow the engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.

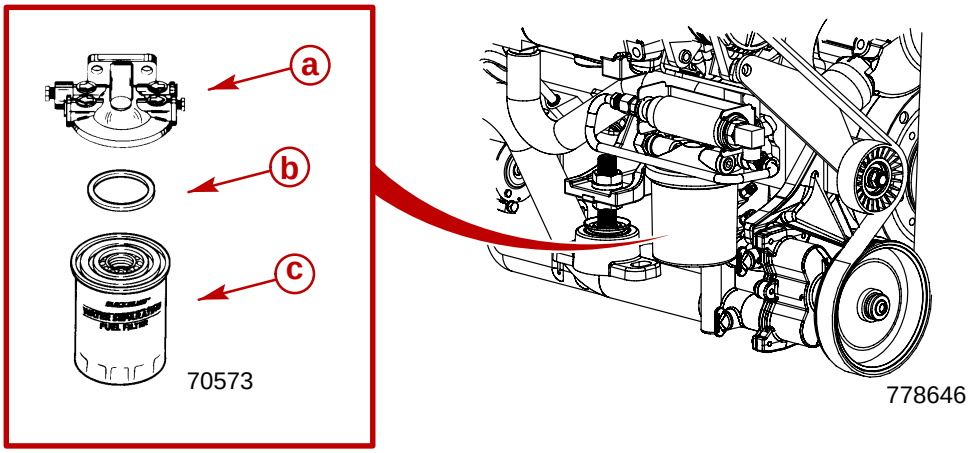
4. Wrap the water separating fuel filter with a cloth to help catch any fuel spills or spray.
5. Remove and discard the water separating fuel filter and sealing ring from the mounting bracket.

Installation

1. Lubricate sealing ring of new filter.

Description	Where Used	Part Number
Engine Oil	Filter sealing ring	Obtain Locally

2. Install a new filter. Tighten securely by hand.



a - Fuel filter base
b - Sealing ring
c - Fuel filter

3. Connect both battery cables to the battery.
4. Supply water to cooling system.

⚠ WARNING

Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

5. Start engine.

⚠ WARNING

Ensure that no fuel leaks exist before closing the engine hatch.

6. Check for fuel leaks.

In-line Fuel Filter (MPI only excluding Alpha)

Installation

IMPORTANT: If the engine is equipped with a boost pump, an inline filter must be installed between the fuel tank and the boost pump.

NOTE: *Per ABYC and Coast Guard regulations, the fuel filter does not need to be grounded.*

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables from the battery.
2. Install boat fuel line from the tank to the engine.
3. With the engine installed, locate a section of the fuel line in a serviceable location, leaving enough room for filter, connections and bracket mounting.
4. Remove 76 mm (3 in.) of fuel line in mounting location.
5. Select appropriate size connector for the fuel line.

IMPORTANT: Use of fittings other than those supplied by Mercury MerCruiser is acceptable as long as they do not exceed the maximum specified fuel pressure drop. Refer to the Mercury MerCruiser Applications Manual for more information on fuel pressure specifications.

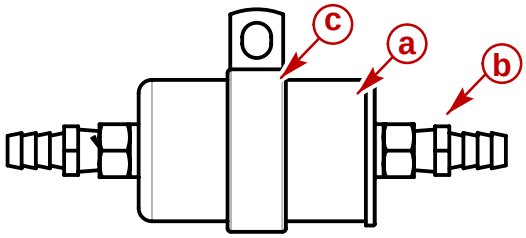
6. Apply sealant to the male pipe threads on the fuel line connectors.

Description	Where Used	Part Number
Loctite 565 PST	Fuel line connectors male pipe threads	Obtain locally

7. Install the connector on the filter.
8. Torque the fuel line connectors.

Description	Nm	lb-in.	lb-ft
Fuel line connectors	19-27		14-20

9. Insert filter into the mounting clip.



78289

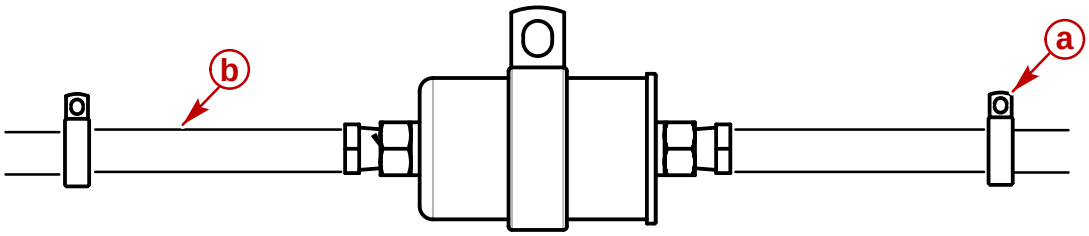
a - In-line filter
b - Connectors
c - Mounting clip

IMPORTANT: Per Coast Guard Regulation (CFD 183.570), "each fuel filter and strainer must be supported on the engine or the boat structure independent from its fuel line connections, unless the fuel filter or strainer is inside a fuel tank."

10. Install and torque screw and washer through the mounting clip into the stringer.

Description	Nm	lb-in.	lb-ft
Mounting clip screw	12	108	

11. Install and torque hose clamps over hose and insert barbs into hose.



78289

a - Fuel line stringer clips
b - Fuel line

Description	Nm	lb-in.	lb-ft
Hose clamps	3.4-6.8	30-60	

12. Inspect the fuel line stringer clips to ensure that the recommended length between clips has not been exceeded. The maximum allowable length is 46 cm (18 in.).
13. Pressurize the fuel system and check for leaks. Relieve pressure and then check for leaks again.

SPECIAL INFORMATION ABOUT ELECTRIC FUEL PUMPS (CARBURETED ONLY)

⚠ CAUTION

The electric fuel pump and factory installed water separating fuel filter have been carefully designed to function properly together. Do not install additional fuel filters and/or water separating fuel filters between fuel tank and engine.

IMPORTANT: The maximum measured vacuum at the engine's fuel inlet must not exceed 6.9 kPa (2 in. Hg) at 600, 3000, full throttle rpm, and idle rpm.

The installation of additional filters may cause:

- Fuel vapor locking
- Difficult warm-starting
- Piston detonation due to lean fuel mixture
- Poor driveability

Steering System

1. Inspect the steering system.
2. Ensure that there are no loose, missing, or damaged components.
3. Repair or replace, as necessary.

Remote Control

1. Inspect the remote controls.
2. Ensure that there are no loose, missing, or damaged components.
3. Repair or replace, as necessary.

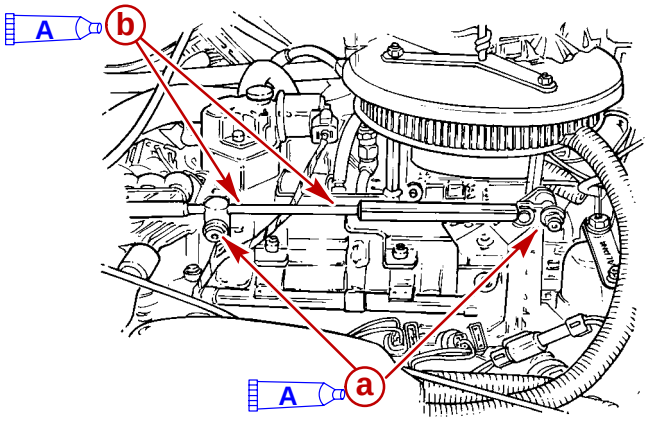
Sterndrive Components

1. Inspect the U-joints.
2. Inspect the engine coupler splines.
3. Inspect the shaft splines.
4. Inspect the bellows.
5. Ensure that there are no loose, missing, or damaged components.
6. Repair or replace, as necessary.

Lubrication

Throttle Cable MPI Models

1. Lubricate the pivot points and the guide contact surfaces.

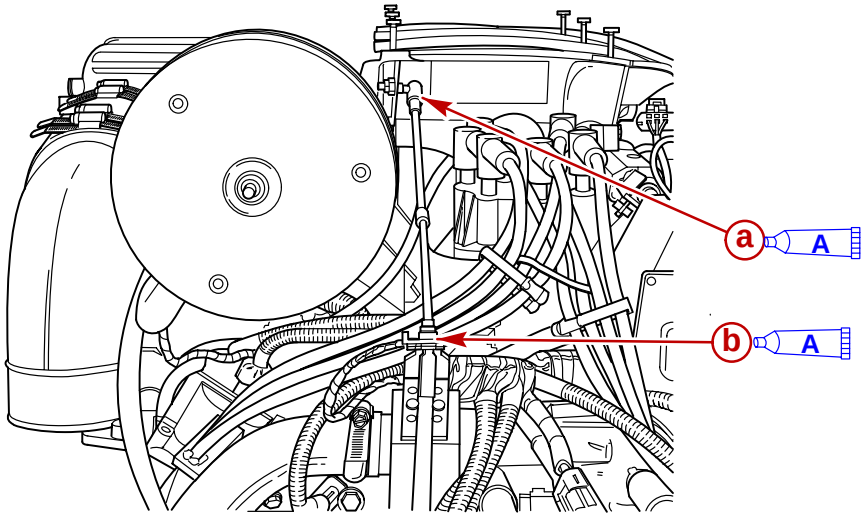


78033

Sterndrive and Inboard models

a - Pivot points
b - Guide contact surfaces

Description		Where Used	Part Number
A	2-4-C with Teflon	Pivot points	92-802859A1



79128

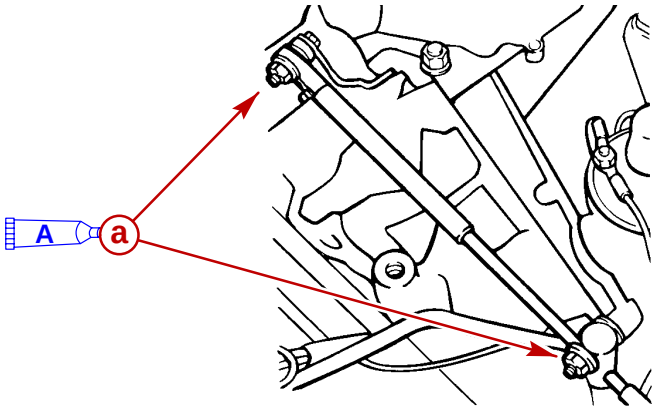
Black Scorpion models shown, other Tow Sports models similar

a - Pivot points
b - Guide contact surfaces

Description		Where Used	Part Number
A	2-4-C with Teflon	Pivot points, guide contact surfaces	92-802859A1

Throttle Cable Carbureted Models

1. Lubricate the pivot points.



71359

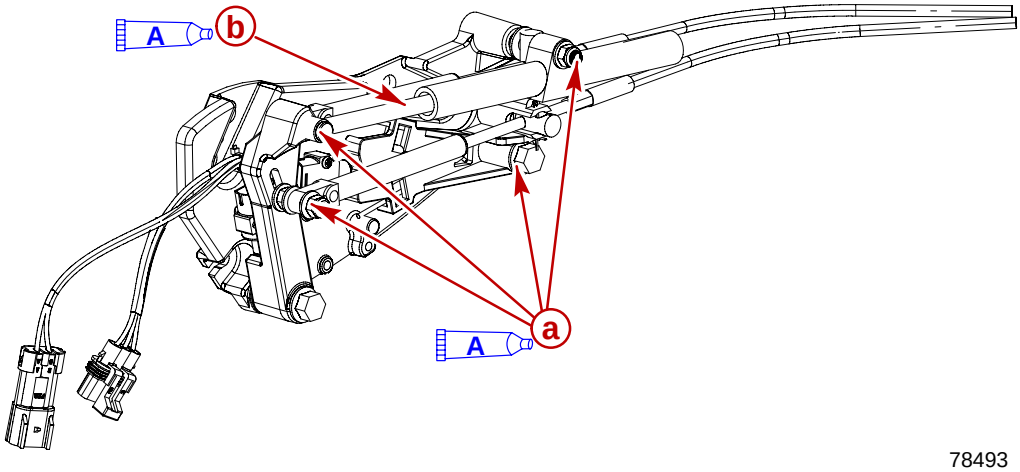
a - Pivot points

Description		Where Used	Part Number
A	Engine Oil	Pivot points, guide contact surfaces	Obtain Locally

Shift Cable Linkage

ALPHA MODELS

1. Lubricate the pivot points and the guide contact surfaces.



78493

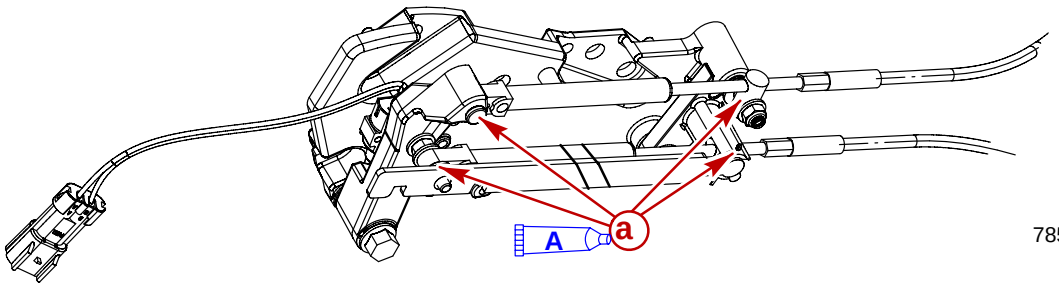
With shift assist assembly

a - Pivot points
b - Guide contact surfaces

Description		Where Used	Part Number
A	Engine Oil	Pivot points, guide contact surfaces	Obtain Locally

BRAVO MODELS

1. Lubricate the pivot points and the guide contact surfaces.



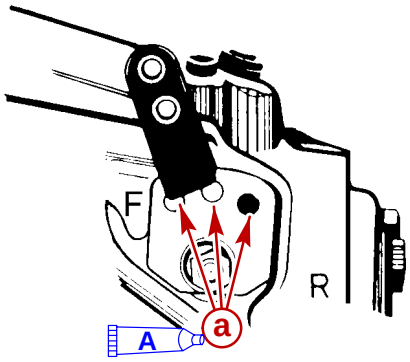
78500

a - Locknut

Description		Where Used	Part Number
A	Engine Oil	Pivot points, guide contact surfaces	Obtain Locally

INBOARD MODELS

1. Lubricate the poppet ball and the holes in the shift lever.



71457

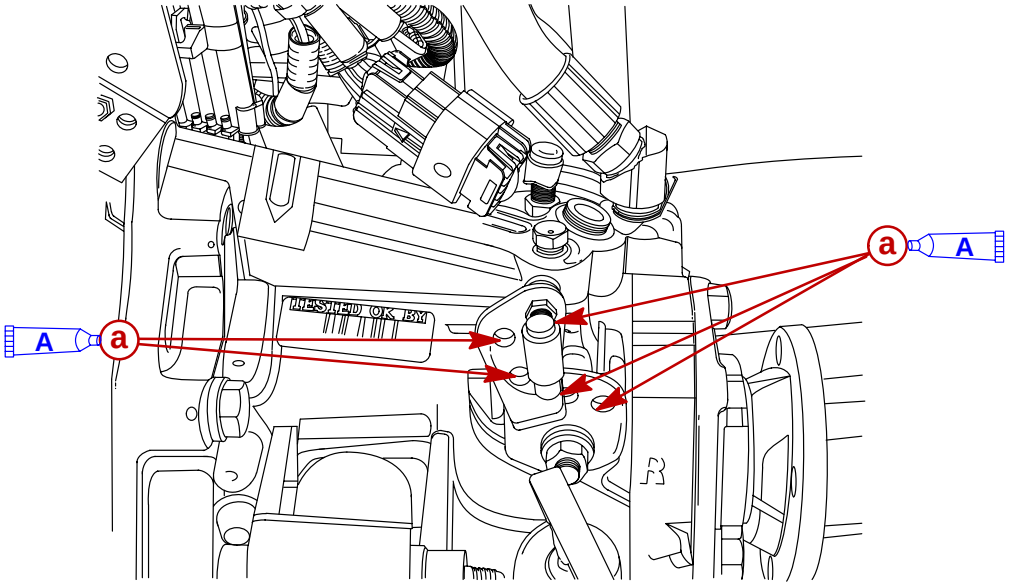
Typical in-line transmission

a - Poppet ball locations

Description		Where Used	Part Number
A	2-4-C with Teflon	Poppet ball and holes	92-802859A1

TOW SPORTS MODELS

1. Lubricate the poppet ball and the holes in the shift lever.



79168

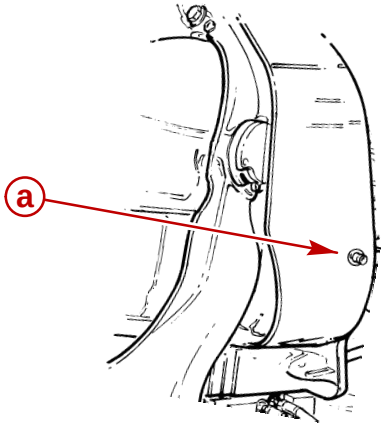
71C In-line shown, other models similar

a - Poppet ball locations

Description		Where Used	Part Number
A	2-4-C with Teflon	Poppet ball and holes	92-802859A1

Gimbal Bearing

1. Lubricate the gimbal bearing by applying approximately 8-10 pumps of grease from a typical hand-operated grease gun.

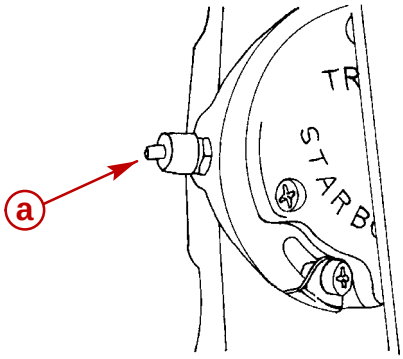


77068

a - Grease fitting

Description	Where Used	Part Number
U-joint And Gimbal Bearing Grease	Gimbal bearings	92-802870A1

a. **Alpha Models -** Lubricate the hinge pins by applying a couple of pumps of grease from a typical hand-operated grease gun.



77044

Serial number 0M659999 and below

a - Grease fitting

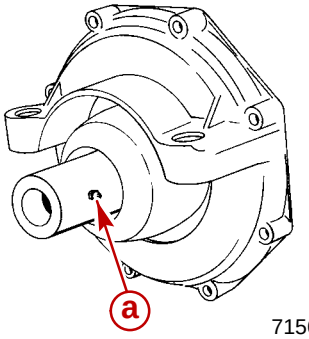
Description	Where Used	Part Number
2-4-C with Teflon	Hinge pins	92-802859A1

Engine Coupler And Shaft Splines

NOTE: *Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual for sterndrive unit removal and installation, if necessary.*

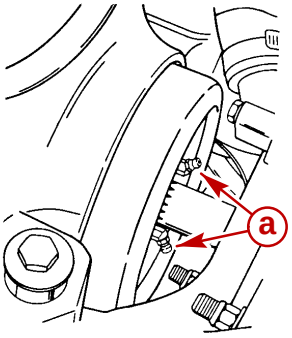
IMPORTANT: These engines are equipped with a sealed engine coupler. The sealed coupler and the shaft splines can be lubricated without removing the sterndrive unit.

1. Lubricate the engine coupler splines through the grease fittings on the coupler by applying approximately 8-10 pumps of grease from a typical hand-operated grease gun. If the boat is operated at idle for prolonged periods of time, the coupler should be lubricated.



71569

Alpha drive coupler



72529

Bravo drive coupler

a - Grease fitting

Description	Where Used	Part Number
Engine Coupler Spline Grease	Engine coupler splines, U-joint shaft splines	92-802869A1

U-joints

NOTE: **Alpha Models** - *Your engine is equipped with Perm-a-Lube U-joints. The Perm-a-Lube U-joints do not require lubrication.*

NOTE: **Bravo Models** - *The crosses and the bearings on some sterndrive U-joints will need to be lubricated through the grease fittings. The sterndrive unit must be removed to grease these fittings. Refer to the chart below for sterndrive U-joint identification.*

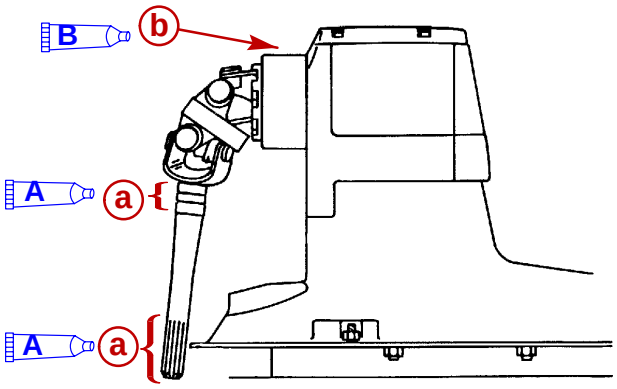
U-JOINT AND PINION GEAR IDENTIFICATION

The following Bravo sterndrive units are equipped with Perm-a-Lube non-regreasable U-joints.	
Dual Water Pickup 1.5:1	0M160890 - Current
Dual Water Pickup 1.36:1	0M130898 - Current
Dual Water Pickup 1.50:1	0M161523 - Current
Dual Water Pickup 1.65:1	0M168818 - Current
Bravo One 1.5:1	0M111208 - Current
Bravo Two 1.5:1	0M158602 - Current
Bravo Two 2.0:1	0M133422 - Current
Bravo Two 2.2:1	0M163866 - Current
Bravo Three 1.5:1	0M141102 - Current
Bravo Three 1.65:1	0M171803 - Current
Bravo Three 1.81:1	0M159838 - Current
Bravo Three 2.0:1	0M166042 - Current
Bravo Three 2.2:1	0M150340 - Current
Bravo Three 2.43:1	0M129436 - Current

LUBRICATION

1. Remove the sterndrive unit; refer to the appropriate Mercury MerCruiser Sterndrive Service Manual for sterndrive unit removal and installation.
2. Apply grease from a typical hand-operated grease gun until a small amount of grease begins to push out.

3. Lubricate the U-joint shaft splines.



72531

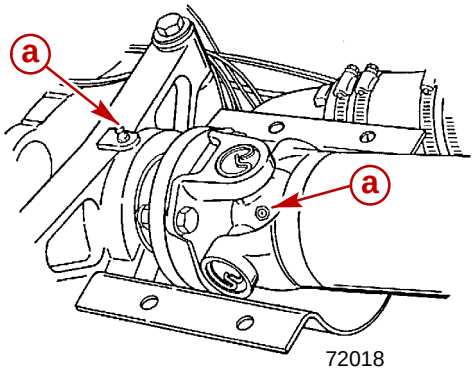
Typical Bravo drive

a - Coupler splines
b - Grease fitting

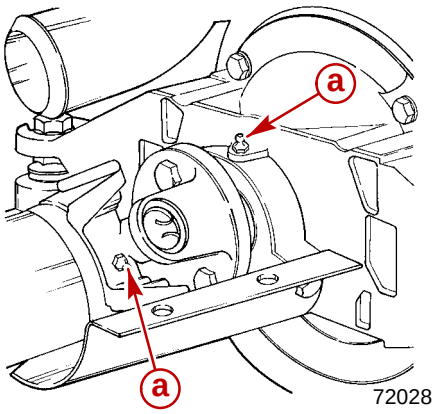
Description		Where Used	Part Number
A	Engine Coupler Spline Grease	Engine coupler splines, U-joint shaft splines	92-802869A1
B	U-joint And Gimbal Bearing Grease	Sterndrive unit U-joint crosses and bearings, drive shaft	92-802870A1

DRIVE SHAFT EXTENSION MODELS

1. Lubricate the drive shaft grease fittings at the transom end by applying approximately 10-12 pumps of grease from a typical hand-operated grease gun.
2. Lubricate the drive shaft grease fittings at the engine end by applying approximately 3-4 pumps of grease from a typical hand-operated grease gun.



72018



72028

Transom end **Engine end**

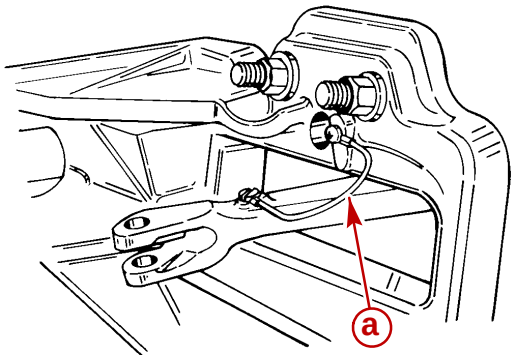
a - Grease fitting

Description	Where Used	Part Number
U-joint And Gimbal Bearing Grease	Sterndrive unit U-joint crosses and bearings, drive shaft	92-802870A1

Continuity Circuit

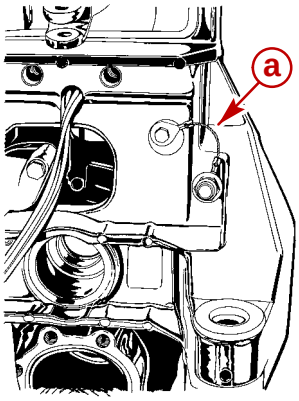
The transom assembly and the sterndrive unit are equipped with ground circuit wires to ensure good electrical continuity between the engine, the transom assembly and the sterndrive components. Good continuity is essential for the Anode and the MerCathode System to function effectively.

1. Inspect the following ground circuit components for loose connections, broken or fraying wires.

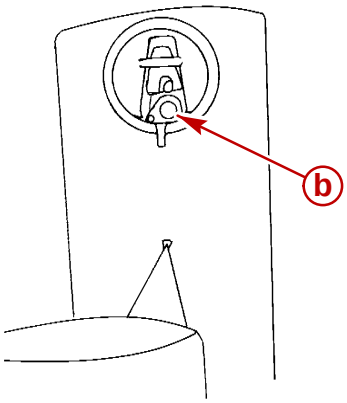


22028

a - Steering lever ground wire

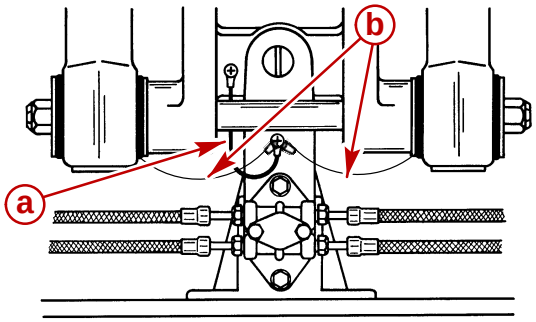


22650



77079

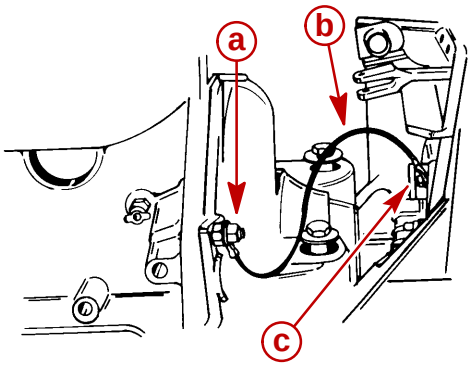
a - Inner transom plate to gimbal housing ground wire
b - Driveshaft housing to gear housing ground plate (inside anode cavity)



77100

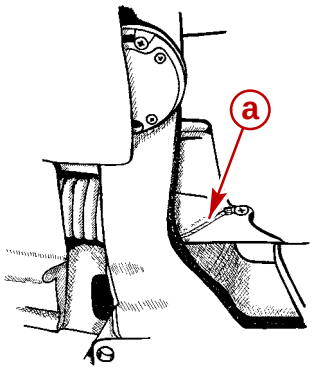
a - Gimbal housing to gimbal ring ground wire
b - Gimbal ring to trim cylinder ground wires

Continuity Circuit (continued)

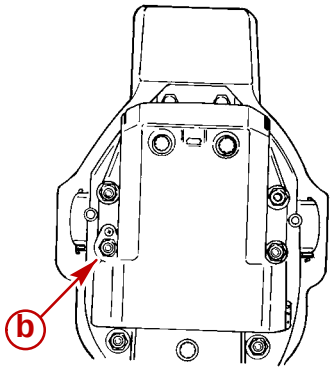


22028

a - Flywheel housing grounding stud
b - Ground wire
c - Inner transom plate grounding screw

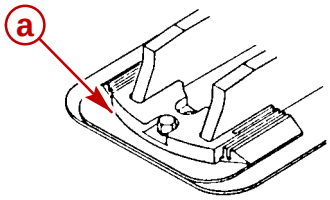


22755

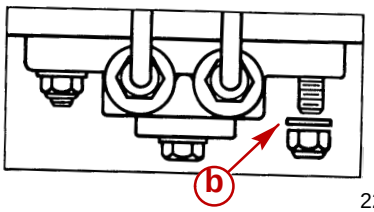


22031

a - Gimbal ring to bell housing ground wire
b - Sterndrive unit to bell housing ground plate

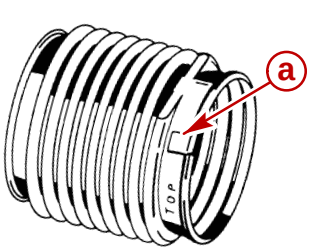


70575

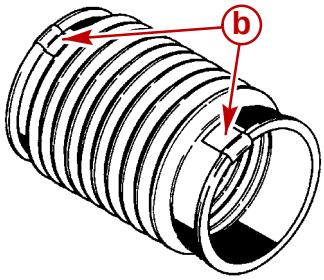


22230

a - Driveshaft housing to gear housing anodic plate
b - Hydraulic connector block to gimbal housing ground washer



50383

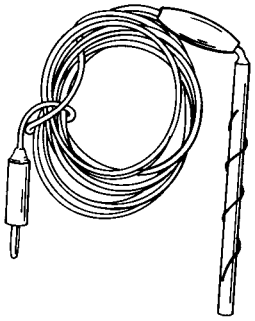


22079

a - U-joint bellows ground clip
b - Exhaust bellows ground clips

MerCathode

If the boat is equipped with a MerCathode System, the system should be tested to ensure that it is providing adequate output to protect the underwater metal parts on the boat. The test should be made where the boat is moored, using Quicksilver Reference Electrode and Test Meter.

Reference Electrode		
 73446	Senses an electrical current in the water when testing the MerCathode system. Use to check hull potential.	91-76675T1

Refer to the appropriate Mercury MerCruiser Sterndrive Service Manual for testing procedures.

Engine Mounts

1. Torque the rear engine mounts. Refer to **SECTION 2**.

Description	Nm	lb-in.	lb-ft
Rear engine mounts	47		35

Electrical System

NOTE: *Refer to* ***SECTION 4*** *for specific procedures.*

1. Inspect the spark plugs.
2. Inspect the spark plug wires.
3. Inspect the distributor cap.
4. Inspect the entire electrical system for loose, damaged, or corroded fasteners.
5. Repair or replace as necessary.

Cleaning Flame Arrestor

Carbureted Models

NOTICE
Refer to “Precautions” in this section, BEFORE proceeding.

REMOVAL

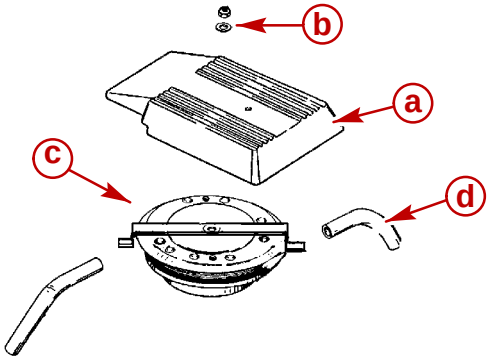
1. Remove nut.
2. Remove sealing washer.
3. Remove carburetor cover.
4. Remove crankcase ventilation hose from flame arrestor and starboard rocker arm cover.
5. Remove Positive Crankcase Vent (PCV) hose to carburetor tube and port rocker arm PCV Valve connection.
6. Remove flame arrestor.

CLEANING AND INSPECTION

1. Clean flame arrestor in solvent and dry with compressed air.
2. Clean crankcase ventilation and PCV hoses.
3. Inspect hoses for cracks or deterioration, and replace if necessary.

INSTALLATION

1. Install flame arrestor.
2. Install crankcase ventilation hose to flame arrestor and starboard rocker arm cover.
3. Install positive crankcase vent (PCV) hose from port rocker arm PCV valve connection to carburetor tube.
4. Install carburetor cover.
5. Install sealing washer.
6. Install nut. Tighten securely.



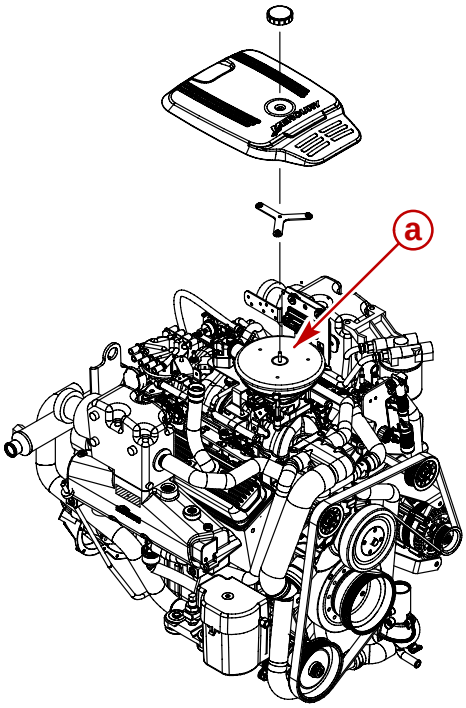
72806

Carbureted model

- **a** - Engine cover
- **b** - Flame arrestor, nuts
- **c** - Flame arrestor
- **d** - Crankcase ventilation hose

MPI Models

1. Remove the engine cover.
2. Remove the crankcase ventilation hose from the fitting on the side of the flame arrestor housing.
3. Remove the flame arrestor.



78020

MPI model

a - Flame arrestor

4. Clean the flame arrestor with water or steam. Dry with compressed air.
5. Clean the crankcase ventilation hose. Dry with compressed air.
6. Inspect the crankcase ventilation hoses for cracks or deterioration and replace if necessary.

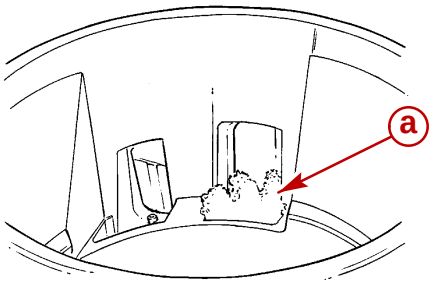
IMPORTANT: Do not use cleaners containing methyl ethyl ketone.

IMPORTANT: Do not get solvent or cleaner on the TPS.

IMPORTANT: Do not damage the adapter and throttle body when removing gasket material from adapter and throttle body.

7. Carefully remove all gasket material from adapter and throttle body.

8. Remove the IAC muffler.



77927

a - IAC muffler installed in throttle body

9. Thoroughly clean all parts of throttle body. Ensure that all passages are free of dirt and burrs.
10. Inspect mating surfaces for damage that could affect gasket sealing.
11. Inspect throttle body for cracks in casting.
12. Inspect throttle plates, linkage, return springs and other components for damage, wear and foreign material.

Installation

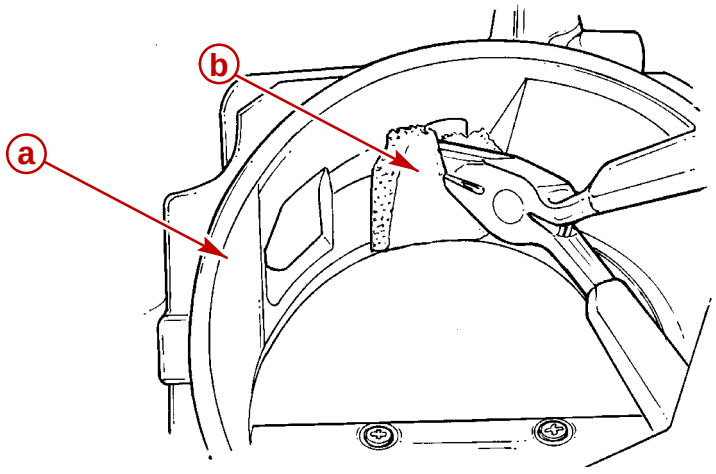
1. Install a new throttle body sealing ring into the groove in the throttle body.
2. Align the dowels and install the throttle body onto the upper intake manifold.
3. If reusing the fasteners, apply adhesive to the threads of the throttle body attaching studs.

Description	Where Used	Part Number
Loctite 242 Threadlocker	Throttle body studs	92-809821

4. Install the throttle body attaching studs. Torque the studs.

Description	Nm	lb-in.	lb-ft
Throttle body studs	9	80	

5. Install the IAC muffler.



77926

a - Throttle body
b - IAC muffler

6. Install the throttle cable bracket.

NOTE: *Ensure that the stud and nut are threading correctly.*

Description	Nm	lb-in.	lb-ft
Throttle cable bracket nuts	19	168	

7. Install the IAC hose to the IAC plug.
8. Install the flame arrestor bracket and tighten the nuts.

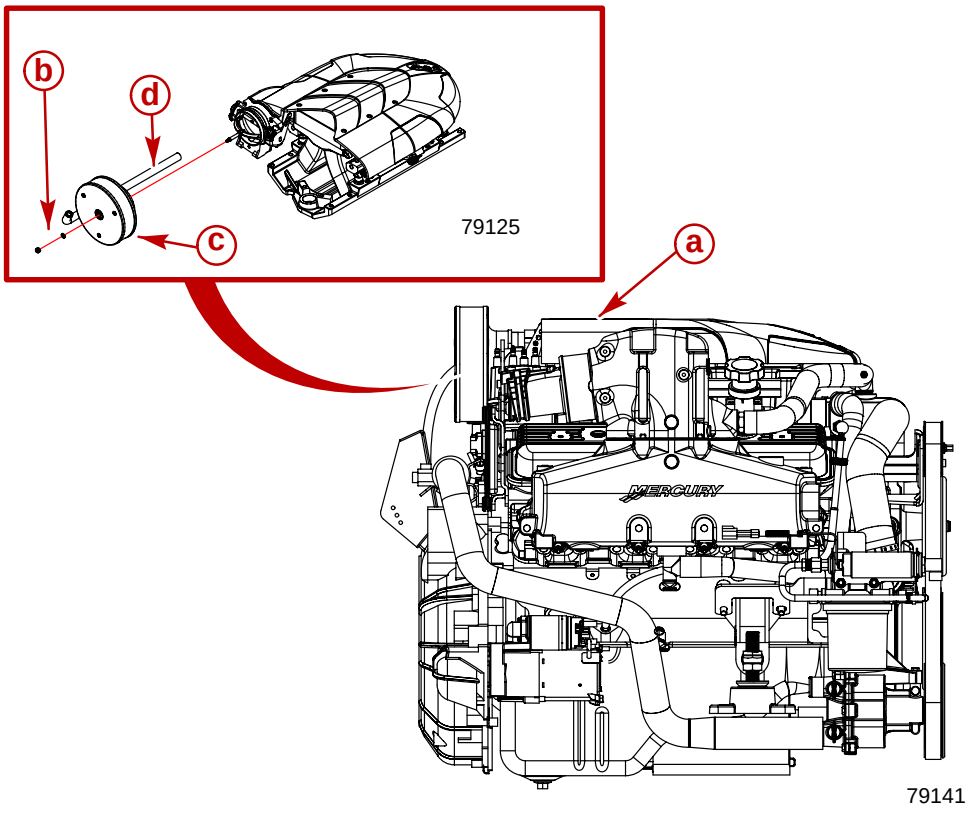
Description	Nm	lb-in.	lb-ft
Flame arrestor retainer bracket nut	12	108	

9. Install the crankcase ventilation hose.
10. Install the engine cover.

Scorpion Models

REMOVAL

1. Remove the crankcase ventilation hose from the fitting on the side of the flame arrestor housing.
2. Remove the 7/16 in. nut and washer; then remove the flame arrestor.



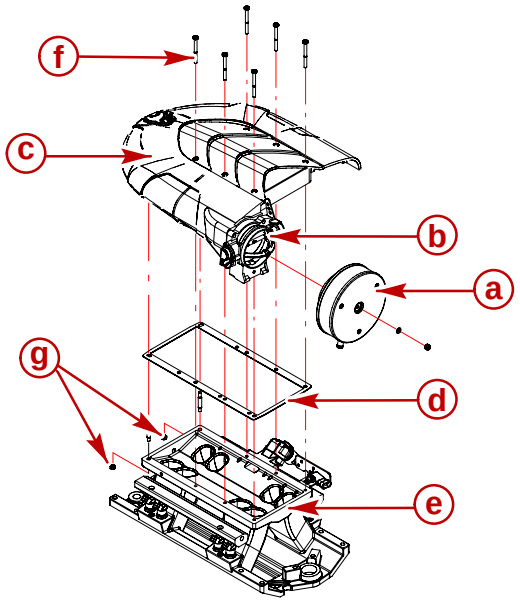
a - Plenum
b - Flame arrestor nut and washer
c - Flame arrestor
d - Crankcase ventilation hose

3. Clean the flame arrestor in water or steam. Dry with compressed air or allow to air dry completely.
4. Clean the crankcase ventilation hose. Dry with compressed air or allow to air dry completely.
5. Inspect the crankcase ventilation hose for cracks or deterioration and replace if necessary.

⚠ WARNING

Avoid personal injury or death and power package damage. The IAC gasket must be replaced anytime the IAC is removed

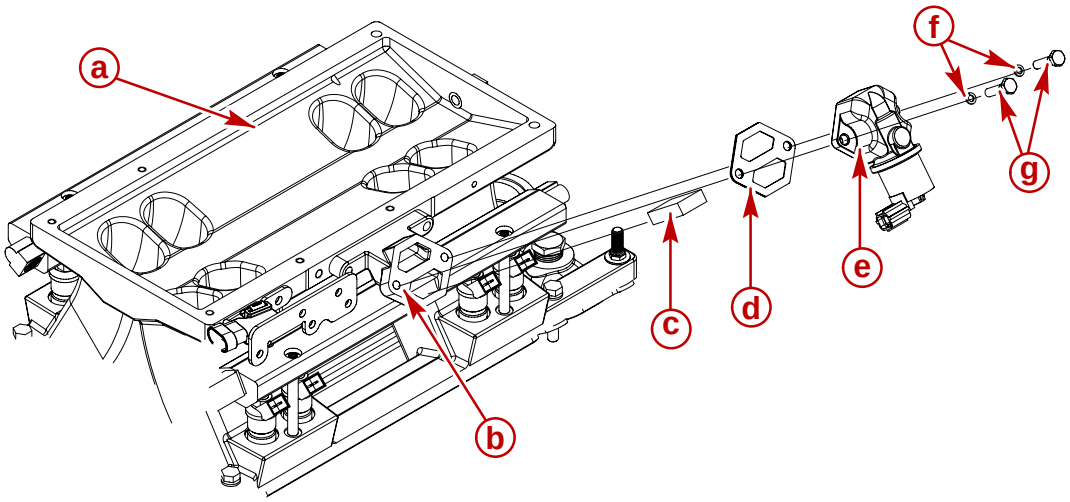
6. Disconnect the throttle cable at the throttle body.
7. Disconnect the electrical connectors to the MAP sensor and the TPS at the throttle body.
8. Remove the plenum and the intake to plenum gasket.



79125

a - Flame arrestor
b - Throttle body
c - Plenum
d - Intake to plenum gasket
e - Intake manifold
f - Plenum screw
g - Plenum nut

9. Cover the intake manifold to prevent debris or contaminants from falling into the intake ports.
10. Remove the IAC from the IAC adaptor.
11. Remove and discard the IAC gasket.
12. Remove and discard the IAC filter from the IAC adaptor.



79302

a - Intake manifold
b - IAC adaptor
c - IAC filter
d - IAC gasket
e - IAC
f - IAC washer
g - IAC screw

INSTALLATION

1. Ensure that the mating surface of the IAC adaptor and the IAC are clean and free of debris.
2. Install IAC filter into the IAC adaptor.
3. install the IAC gasket and the IAC onto the IAC adaptor using the IAC screws and washers. Torque the screws.

Description	Nm	lb-in.	lb-ft
IAC screw 1/4-20 x 25 mm (1 in.) long	11	96	

4. Connect the electrical connector to IAC.
5. Install the intake gasket and the plenum. Torque the plenum screws and nuts.

Description	Nm	lb-in.	lb-ft
Plenum screw	11	96	
Plenum nut	11	96	

6. Connect electrical connectors to the MAP sensor and the TPS.
7. Connect the throttle cable at the throttle body.
8. Install the flame arrestor.
9. Install flame arrestor with the nut and washer. Ensure that the rubber side of the washer is against the flame arrestor.

Description	Nm	lb-in.	lb-ft
Flame arrestor bracket nut	12	108	

Ignition Timing (Carbureted Models Only)

Thunderbolt V Models

1. Connect timing light to number 1 spark plug wire.
2. Connect a shop tachometer to the engine.

IMPORTANT: Before starting the engine, connect a jumper wire from the ignition timing lead to a good ground. This has to be done before the ignition key is turned to the ON position to lock the ignition module into Base Timing Mode.

3. Before starting the engine, connect jumper wire from timing lead to a good ground.

NOTE: *The PUR/WHT timing lead is located toward the front of the engine near the fuel line or near the distributor, as equipped for your model.*

4. Start engine and run at 1300 rpm until it reaches normal operating temperature.
5. Disconnect throttle cable from the carburetor.
6. With engine at idle rpm, adjust the carburetor idle rpm screw to the specified engine idle rpm.
7. With the engine still at idle rpm, check the ignition timing. If incorrect, rotate the distributor until timing is correct. Torque clamping screw.

Description	Nm	lb-in.	lb-ft
Distributor clamping screw	25		18

8. Adjust the idle mixture screw. Inward is LEAN, outward is RICH.
9. Recheck ignition timing.
10. Stop engine. Remove timing light, jumper wire and shop tachometer.

IMPORTANT: Timing jumper wire has to be removed or the ignition module will stay locked in the Base Timing Mode and it will not be able to advance the ignition timing correctly when the engine rpm is increased.

11. Reinstall and adjust throttle cable. Open and close remote control throttle lever to ensure that carburetor's throttle lever returns against rpm adjusting screw every time.
12. Start the engine, and increase rpm to 1300; then return to idle position slowly and shut the engine off. Ensure that the carburetor throttle lever returned against the idle rpm screw.
13. Shut engine off.

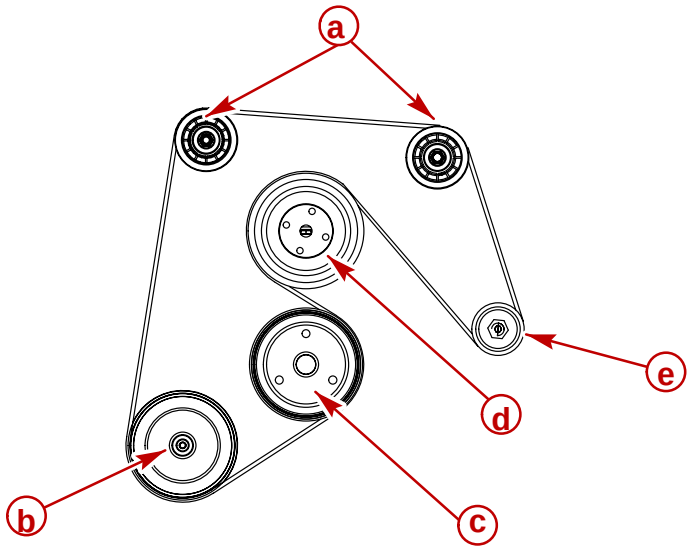
Serpentine Drive Belt

⚠ WARNING

Avoid possible serious injury. Ensure that the engine is shut off and the ignition key is removed before inspecting the belt.

IMPORTANT: The brackets and washers on the 3 idler pulleys must be in a certain order or the serpentine belt will come off. All pulleys are referenced as though you were standing in front of the engine looking at the belt.

Inboard and Tow Sports Models

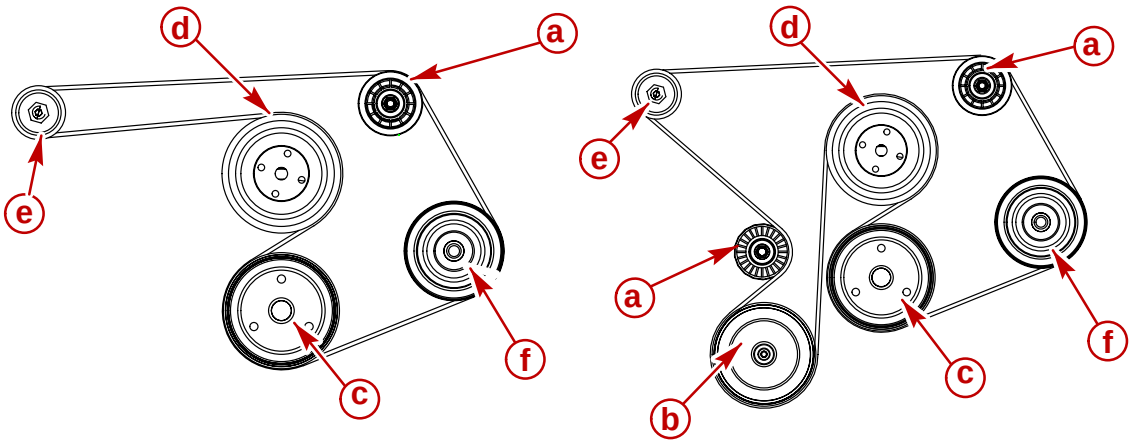


76503

Typical

- **a** - Idler pulley
- **b** - Seawater pump pulley
- **c** - Crankshaft pulley
- **d** - Circulating pump pulley
- **e** - Alternator pulley

Sterndrive Models



Without a seawater pump **With a seawater pump**

- **a** - Idler pulley
- **b** - Seawater pump pulley
- **c** - Crankshaft pulley
- **d** - Circulating pump pulley
- **e** - Alternator pulley
- **f** - Power steering pulley

Inspection

⚠ WARNING

Avoid possible serious injury. Ensure that the engine is shut off and the ignition key is removed before inspecting the belt.

1. Inspect the drive belt for the following:

- Excessive wear
- Cracks

NOTE: Minor, transverse cracks (across the belt width) may be acceptable. Longitudinal cracks (in the direction of belt length) that join transverse cracks are not acceptable.

- Fraying
- Glazed surfaces
- Proper tension - 15-19 mm (5/8-3/4 in.) deflection, with moderate thumb pressure, on the belt at the location that has the longest distance between 2 pulleys.

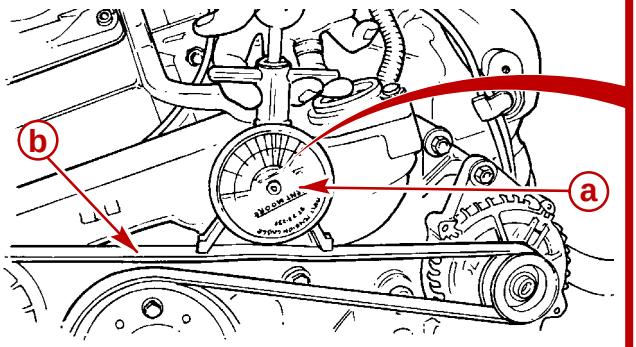
Replacing Belt and/or Adjusting Tension

REMOVAL

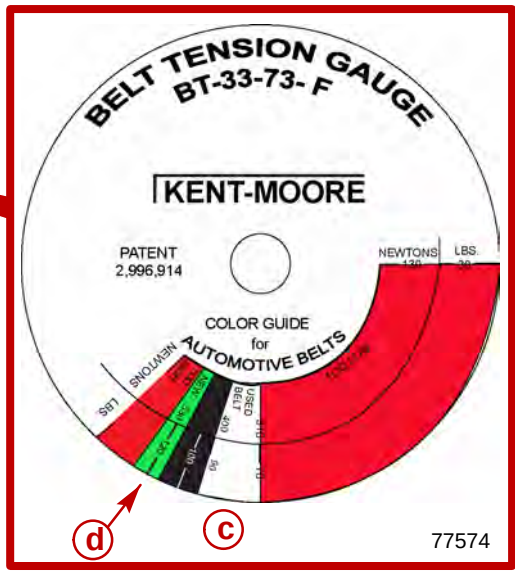
1. Loosen the 5/8 in. locking nut on the adjustment stud.
2. Turn the adjustment stud and loosen the belt.
3. Remove the serpentine drive belt.

INSTALLATION AND ADJUSTMENT

1. Install the serpentine drive belt onto the pulleys.
2. Put a wrench on the adjustment stud 5/8 in. locking nut.
3. Use a 5/16 in. socket and tighten adjusting the stud to adjust the belt deflection.
4. Ensure that the correct deflection has been obtained.
   a. Push down with moderate thumb pressure on the longest stretch of belt.
   b. Attach the Kent Moore Belt Tension Gauge to the belt. The gauge has different ranges for new and used belts.



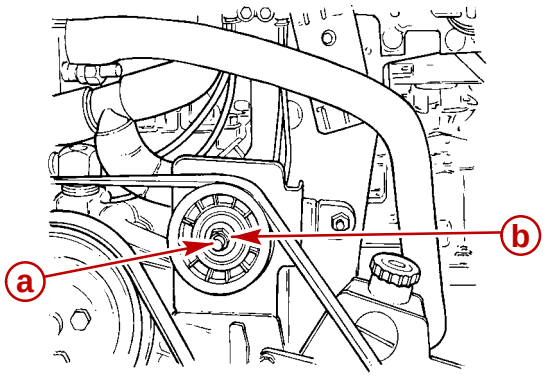
77573



77574

a - Kent Moore tension gauge
b - Serpentine belt
c - Used range
d - New range

5. While holding the adjustment stud at the correct belt tension, tighten the 5/8 in. locking nut.



77827

a - 5/8 in. locking nut
b - 5/16 in. adjusting stud

6. Operate the engine for a short period of time and recheck the belt adjustment.

Exhaust System

NOTE: *Refer to* ***SECTION 7****.*

1. Ensure that all hose clamps are tight and connections are secure.
2. Inspect the entire system for damage or leaks.
3. Repair or replace as necessary.

Seawater Pump

NOTE: *Refer to* ***SECTION 6A****.*

1. Inspect the seawater pump components; replace as necessary.

Cold Weather And Extended Storage

IMPORTANT: Mercury MerCruiser strongly recommends that this service should be performed by an authorized Mercury MerCruiser dealer. Damage caused by freezing IS NOT covered by the Mercury MerCruiser Limited Warranty.

⚠ CAUTION

Sterndrive unit should be stored in the full DOWN position. Universal joint bellows may develop a set if unit is stored in raised position and may fail when unit is returned to service.

IMPORTANT: Mercury MerCruiser recommends that propylene glycol antifreeze (a nontoxic and environmentally safe antifreeze) be used in the seawater section of the cooling system for cold weather or extended storage. Ensure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Follow the propylene glycol manufacturer's recommendations.

⚠ CAUTION

The seawater section of the cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exist. Failure to comply may result in trapped water causing freeze and/or corrosion damage to the engine. Damage caused by freezing is not covered by the Mercury MerCruiser Limited Warranty.

Preparing Your Power Package For Storage

1. Drain the water from the seawater section of the cooling system.
2. Flush the seawater section of the cooling system.
3. Change the oil and oil filter.
4. Clean the seawater strainer, if equipped. Follow manufacturer's instructions.
5. Winterize the fuel tank. Refer to FUEL TANKS.
6. Attach a portable fuel tank to the power package to complete winterization.
7. Winterize the Fuel System.
8. Fill the seawater section of the cooling system with the appropriate mixture of propylene glycol and water.
9. Close the seacock or remove and cap the seawater inlet hose.
10. Lubricate all cables and linkages.
11. Check all hose clamps for tightness.
12. Perform all other annual checks listed in the Maintenance charts.
13. Clean the engine and coat with corrosion guard.
14. Place the sterndrive unit in the full DOWN/IN position.
15. Store the battery as per the manufacturer's specifications.

FUEL TANKS

1. Fill the fuel tanks with fresh gasoline (that does not contain alcohol) and a sufficient amount of Mercury Fuel System Treatment and Stabilizer to treat the gasoline. Follow instructions on the container.
2. **If the boat is to be placed in storage with fuel containing alcohol in fuel tanks (if fuel without alcohol is not available):** Fuel tanks should be drained as low as possible and Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank.

CARBURETED FUEL SYSTEM

1. Prepare carbureted fuel system for extended storage as follows:
   a. Start engine and remove the flame arrestor assembly.
   b. While operating engine at fast idle (1300 rpm), fog internal surfaces of induction system and combustion chambers by squirting approximately 227 g (8 oz) of Quicksilver Storage Seal or SAE 20W engine oil into carburetor bores.
   c. Squirt the remaining 57 g (2 oz.) of Storage Seal (or oil) rapidly into carburetor, just as the engine begins to stall, due to lack of fuel. Allow engine to stop.

Description	Where Used	Part Number
Storage Seal Rust Inhibitor	Carburetor	92-802878-56

   d. Turn ignition key to OFF position.
   e. Refer to Flushing Cooling System and appropriately remove water supply to the seawater pickup pump.
2. Clean flame arrestor and crankcase ventilation hoses and reinstall.
3. Lubricate all items listed in Lubrication section.
4. Drain seawater section of cooling system as outlined in Draining Instructions section.
5. **On Models with Closed Cooling System:** Test coolant to ensure that it will withstand the lowest temperature expected during storage.
6. Clean outside of engine and repaint any areas required with Primer and Spray Paint. After paint has dried, wipe down with Storage Seal rust inhibitor.

Description	Where Used	Part Number
Storage Seal Rust Inhibitor	Carburetor	92-802878-56
Light gray primer	Outside of engine	92-802878-52
Phantom black paint	Outside of engine	92-802878-1

7. For sterndrive unit layup, refer to appropriate Mercury Mercruiser Sterndrive Service Manual.

NOTE: *For additional protection against freezing and rust to the exhaust manifolds and other components, a 50-50 mixture of antifreeze and water can be run through the engine during Power Package Layup.*

MPI FUEL SYSTEM

⚠ WARNING

The fuel injection system is pressurized. Avoid serious injury from an explosion. Use care when removing water separating fuel filter. Allow engine to cool down before removing the water separating fuel filter. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.

⚠ WARNING

Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

1. In a 23 liter (6 U.S. gal) remote fuel tank mix:
   a. 19 liter (5 U.S. gal) regular unleaded 87 octane (90 RON) gasoline
   b. 1.89 liter (2 U.S. qt.) Premium Plus 2-Cycle TC-W3 Outboard Oil
   c. 150 ml (5 oz) Fuel System Treatment and Stabilizer or 30 ml (1 oz) Fuel System Treatment and Stabilizer Concentrate.

Description	Where Used	Part Number
Mercury Fuel System Treatment and Stabilizer	Fuel System	92-802875A1
Mercury Fuel System Treatment and Stabilizer Concentrate	Fuel System	92-802876A1
Premium Plus 2-Cycle TC-W3 Outboard Oil	Fuel System	92-802824A1

2. Allow the engine to cool down.
3. Activate the Schrader valve to relieve fuel pressure.
4. Close the fuel shut-off valve, if equipped. Disconnect and plug the fuel inlet fitting if not equipped with a fuel shut-off valve.
5. Connect the remote fuel tank (with the fogging mixture) to the fuel inlet fitting.

IMPORTANT: Supply cooling water to the engine.

6. Start and operate the engine at 1300 rpm for 5 minutes.
7. After specified operating time is complete, slowly return throttle to idle rpm and shut engine off.

8. Lubricate all items listed in Lubrication section.
9. Drain seawater section of cooling system as outlined in Draining Instructions section.
10. **On Models with Closed Cooling System:** Test coolant to ensure that it will withstand the lowest temperature expected during storage.
11. Clean outside of engine and repaint any areas required with Primer and Spray Paint. After paint has dried, wipe down with Storage Seal rust inhibitor.

Description	Where Used	Part Number
Storage Seal Rust Inhibitor	Carburetor	92-802878-56
Light gray primer	Outside of engine	92-802878-52
Phantom black paint	Outside of engine	92-802878-1

12. For sterndrive unit layup, refer to appropriate Mercury MerCruiser sterndrive service manual.

IMPORTANT: Ensure that some fogging mixture remains in the engine. Do not allow the engine's fuel system to become completely dry.

13. Remove and discard the water separating fuel filter.
14. Install a new filter.

Draining Instructions

⚠ CAUTION

Ensure that boat is out of the water or seacock is closed and bilge pump is operating before beginning procedure. Excess water in bilge can damage engine or cause boat to sink.

⚠ CAUTION

Do not operate engine with drain system open. Excess water in bilge can damage engine or cause boat to sink.

IMPORTANT: Boat must be as level as possible to ensure complete draining of cooling system.

Your power package is equipped with 1 of 3 drain systems. Refer to Identification on the following page to determine which instructions apply to your power package.

The power package should be drained before flushing or prior to extended or cold weather storage.

IMPORTANT: The boat must not be operating at any point during this procedure.

Identification

CARBURETED MODELS

Description	Water Drain System
5.0L Alpha	7 point manual drain system
5.0L Bravo	7 point manual drain system
5.7L Alpha	7 point manual drain system
5.7L Bravo	7 point manual drain system
5.7L Inboard	7 point manual drain system
5.7L Tow Sports	7 point manual drain system

MPI MODELS

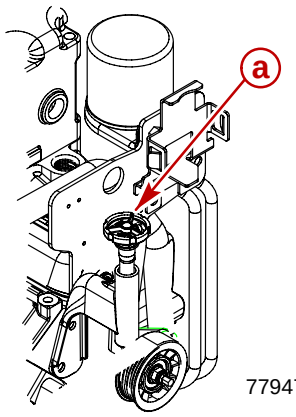
Description	Water Drain System
5.0L MPI Alpha	Manual single point drain (standard) Multi-point drain (MPD) system (optional)
5.0L MPI Bravo	3 point manual drain system (standard) Air actuated single point drain system (optional) Multi-point drain (MPD) system (optional)
350 MAG MPI Alpha	Manual single point drain (standard) Multi-point drain (MPD) system (optional)
350 MAG MPI Bravo	3 point manual drain system (standard) Air actuated single point drain system (optional) Multi-point drain (MPD) system (optional)
350 MAG MPI Horizon Bravo	Air actuated single point drain system (standard)
MX 6.2 MPI Bravo	3 point manual drain system (standard) Air actuated single point drain system (optional) Multi-point drain (MPD) system (optional)
MX 6.2 MPI Horizon Bravo	Air actuated single point drain system (standard)

MPI MODELS (CONTINUED)

Description	Water Drain System
350 MAG MPI Inboard	3 point manual drain system (standard) Air actuated single point drain system (optional)
350 MAG MPI Horizon Inboard	Air actuated single point drain system (standard)
MX 6.2 MPI Inboard	3 point manual drain system (standard) Air actuated single point drain system (optional)
MX 6.2 MPI Horizon Inboard	Air actuated single point drain system

Description	Water Drain System
350 MAG MPI Tow Sports	3 point manual drain system (standard) Air actuated single point drain system (optional)
Scorpion Tow Sports	8 point manual drain system (standard)
MX 6.2 MPI Tow Sports	3 point manual drain system (standard) Air actuated single point drain system (optional)
MX 6.2 Scorpion Tow Sports	8 point manual drain system (standard)

MANUAL SINGLE POINT DRAIN SYSTEM



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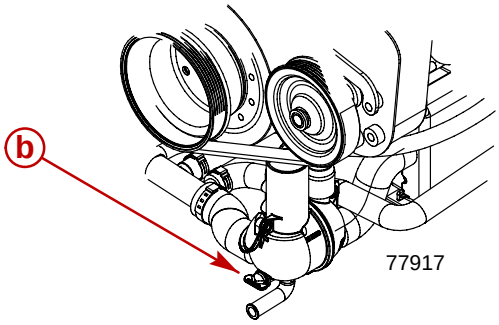

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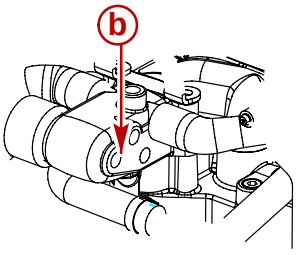
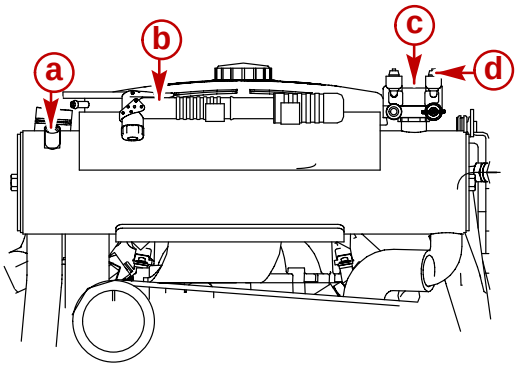
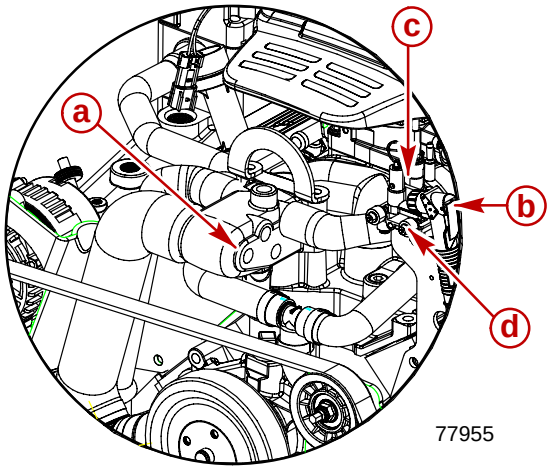


77949

a - Blue handle
b - Blue drain plug location

AIR ACTUATED SINGLE POINT DRAIN SYSTEM

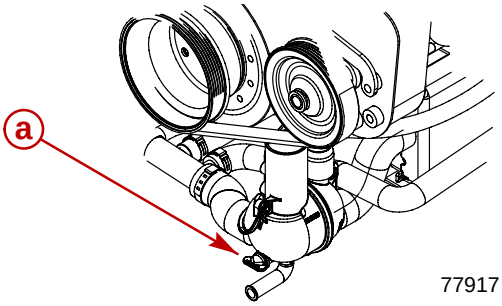


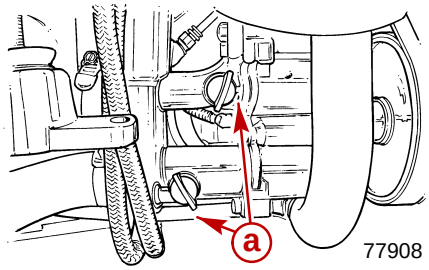


Closed cooled models **Seawater cooled models**

a - Blue drain plug location
b - Blue air pump
c - Air manifold
d - Green indicators

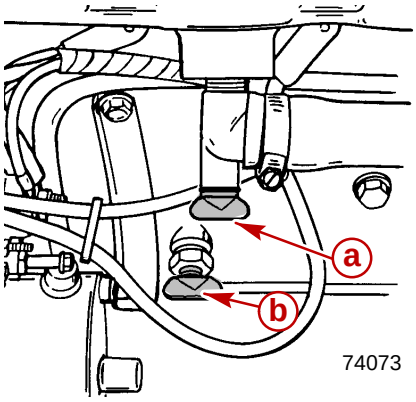
3 POINT MANUAL DRAIN SYSTEM

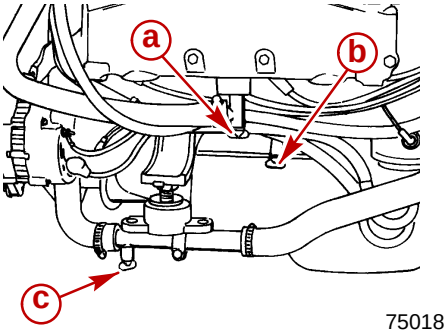




a - Blue drain plug

7 POINT MANUAL DRAIN SYSTEM

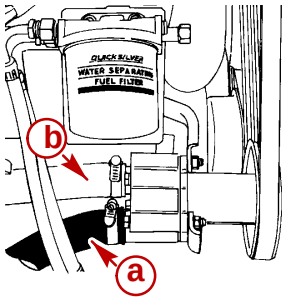


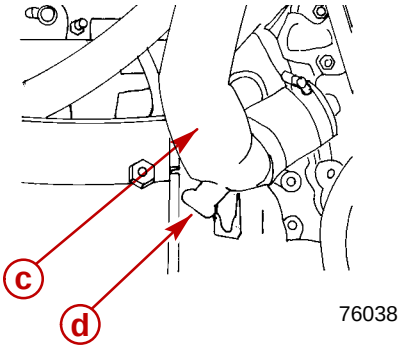


Starboard side

Port side

a - Exhaust elbow drain plug
b - Cylinder block drain plug
c - Water tube drain plug

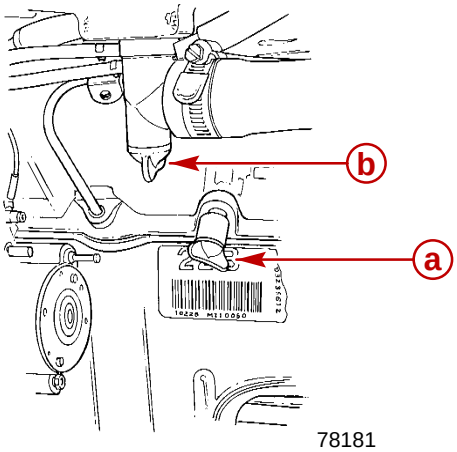




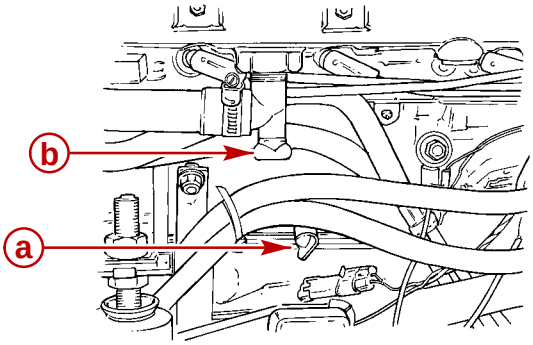
a - Seawater inlet hose
b - Hose to cooler
c - Water circulating pump hose
d - Drain plug

0181.1

MULTI-POINT DRAIN (MPD) SYSTEM

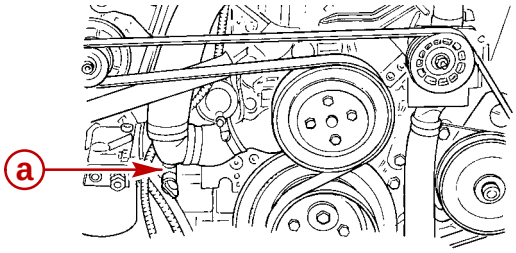


78181

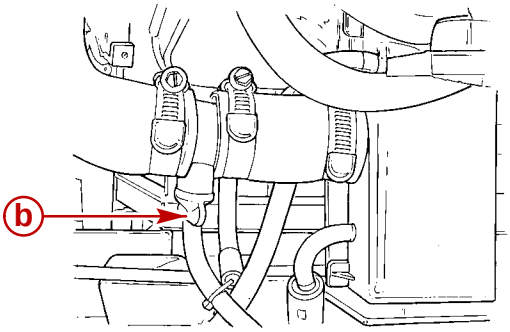


78178

a - Side of cylinder block
b - Bottom of exhaust manifolds

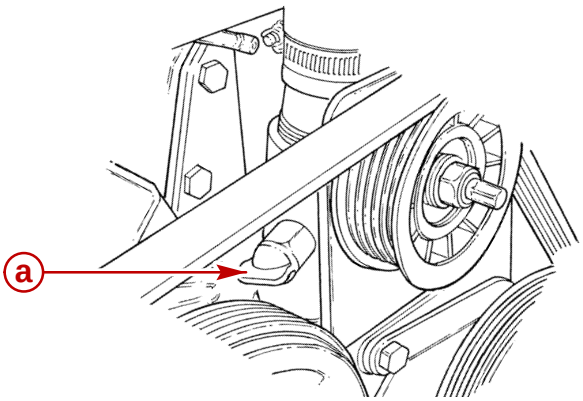


78182



78179

a - Water circulating pump hose
b - Fuel cooler to thermostat housing



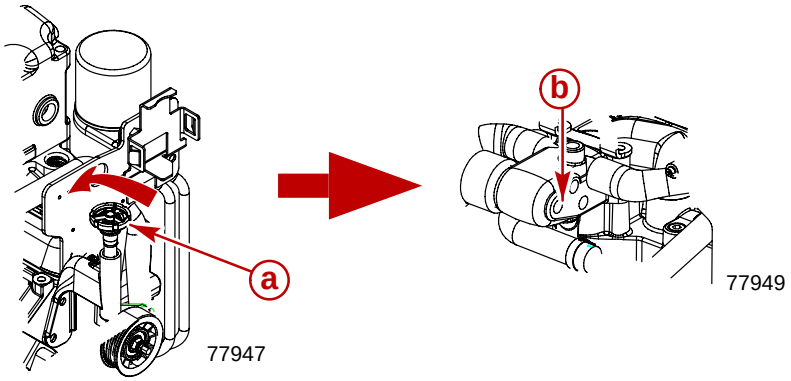
78180

a - Check valve

Boat In The Water

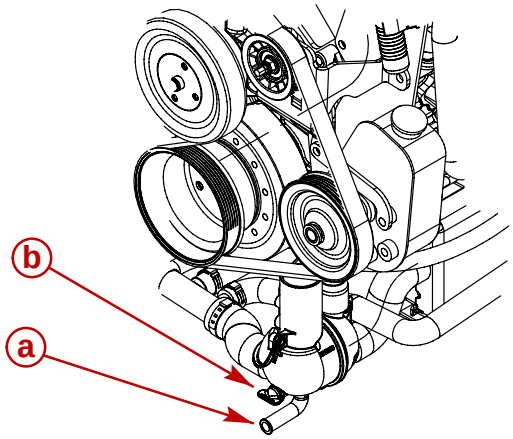
MANUAL SINGLE POINT DRAIN SYSTEM

1. Close the seacock.
2. Rotate the blue handle COUNTERCLOCKWISE until it stops (approximately 2 turns). The red on the handle shaft indicates that the drain system is open. Do not force the handle as this will create new threads.
3. **Immediately** remove the blue drain plug from the side of the thermostat housing. This must be removed within 30 seconds to properly vent the cooling system.



a - Blue handle
b - Blue drain plug location

4. Visually verify that water is draining. If water does not drain, remove blue drain plug from distribution housing and drain manually.



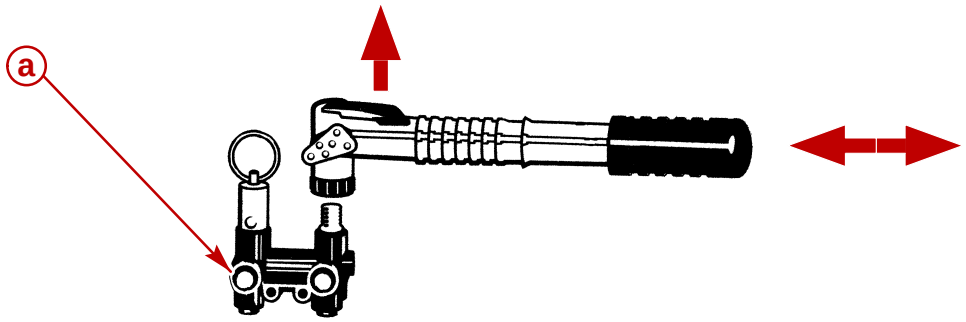
a - Drain location - orange or red
b - Blue drain plug

5. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance.
6. Reinstall the blue drain plug in the thermostat housing.
7. Close the drain system by rotating the blue handle CLOCKWISE until it stops and install the blue drain plug, if removed. The handle is fully seated when no red is visible. Do not overtighten the handle as this will create new threads.
8. Open the seacock prior to operating the engine.

AIR ACTUATED SINGLE POINT DRAIN SYSTEM

NOTE: *This procedure is written for the air pump that is attached to the engine. However, any air source can be used.*

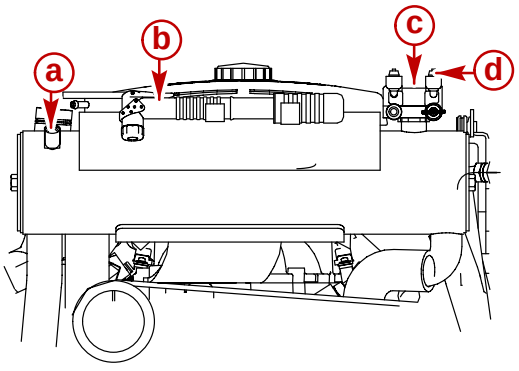
1. Close the seacock.
2. Remove the blue air pump from the engine.
3. Ensure that lever on top of pump is flush with the handle (horizontal).
4. Install the air pump on the fitting in the air manifold.



77638

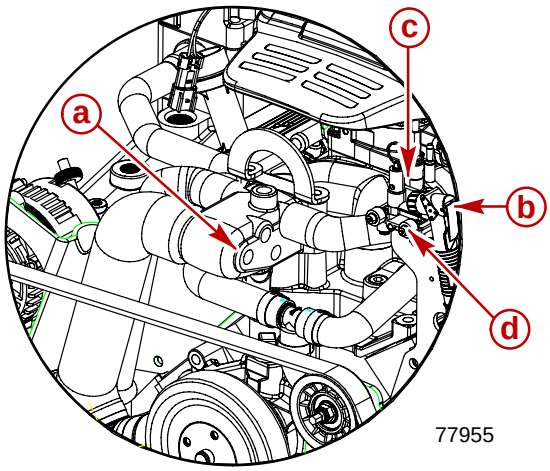
a - Green indicators

5. Pull lever on the air pump up (vertical) to lock pump on the fitting.
6. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.
7. **Immediately** remove the blue drain plug from the side of the thermostat housing or the heat exchanger. This must be removed within 30 seconds to properly vent the cooling system.



77955

Closed cooled models

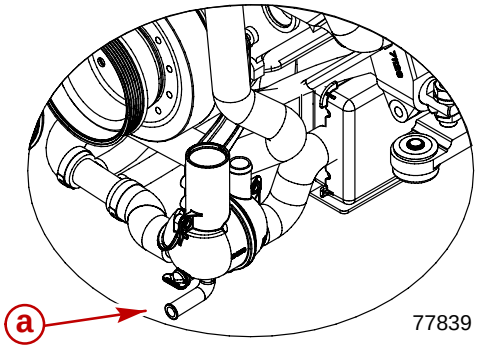


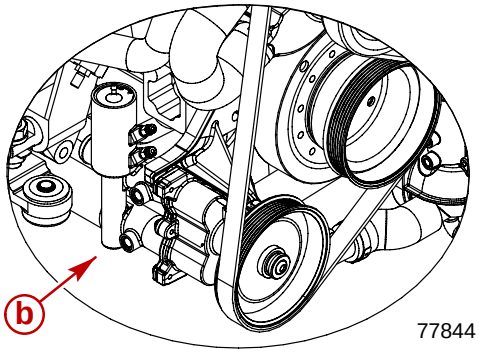
77955

Seawater cooled models

a - Blue drain plug location
b - Blue air pump
c - Air manifold
d - Green indicators

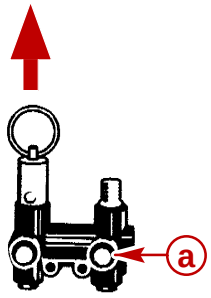
8. Verify that water is draining from each opening. If not, use the 3 Point Manual Drain System instructions.





a - Port side drain location
b - Starboard side drain location

9. Allow the system to drain for a minimum of 5 minutes. Add air as necessary to keep the green indicators extended.
10. Crank engine over slightly with starter motor to purge any water trapped in seawater pump. Do not allow engine to start.
11. Reinstall the blue drain plug in the thermostat housing.
12. Remove the air pump from the air manifold and return it to the mounting bracket.
13. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.
14. Before launching boat, pull up on manual release valve. Verify that green indicators are no longer extended.



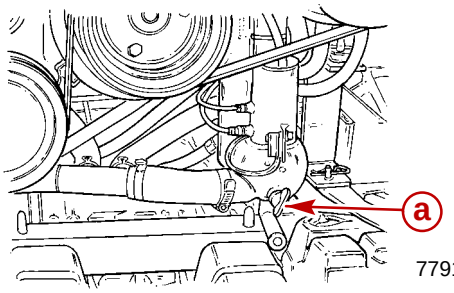
a - Green indicators

15. Open the seacock prior to operating the engine.

3 POINT MANUAL DRAIN SYSTEM

NOTE: *Use this procedure if your engine is not equipped with an air actuated single point drain system or if the single point drain system fails.*

1. Close the seacock.
2. Remove 3 blue drain plugs: 1 from the distribution housing (lower front, port side) and 2 from the seawater pickup pump (front, starboard side).



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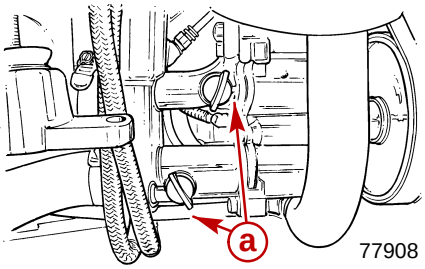
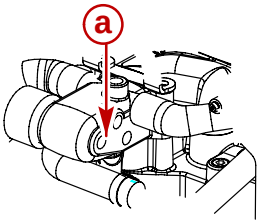


77908

a - Blue drain plug

3. **Immediately** remove the blue drain plug from the side of the thermostat housing. This must be removed within 30 seconds to properly vent the cooling system.



77949

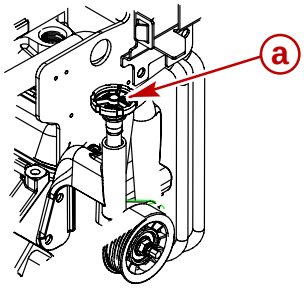
a - Blue drain plug location

4. Verify that water is draining from each opening.
5. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the drain system open while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.
6. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. Do not allow the engine to start.
7. Prior to launching boat or starting the engine, close the drain system by installing the four blue drain plugs.
8. Open the seacock prior to operating the engine.

Boat Out Of The Water

MANUAL SINGLE POINT DRAIN SYSTEM

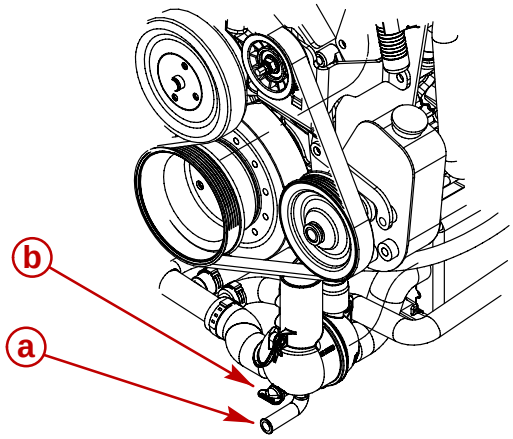
1. Rotate the blue handle COUNTERCLOCKWISE until rotation stops (approximately 2 turns). The red on the handle shaft indicates that the drain system is open. Do not force the handle as this will create new threads.



77947

a - Blue handle

2. Visually verify that water is draining. If water does not drain, remove blue drain plug from distribution housing and allow to drain manually.



77917

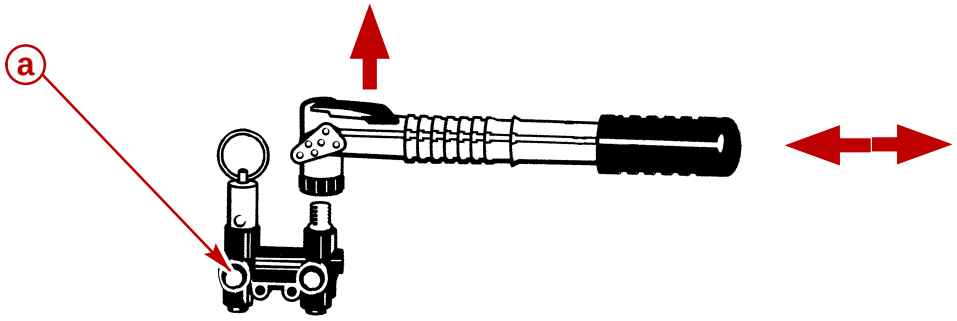
a - Drain location - orange or red
b - Blue drain plug

3. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the plugs out while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.
4. Close the drain system by rotating the blue handle CLOCKWISE until it stops or by installing the blue drain plug. The handle is fully seated when no red is visible. Do not overtighten the handle as this will create new threads.

AIR ACTUATED SINGLE POINT DRAIN SYSTEM

NOTE: *This procedure is written for the air pump that is attached to the engine. However, any air source can be used.*

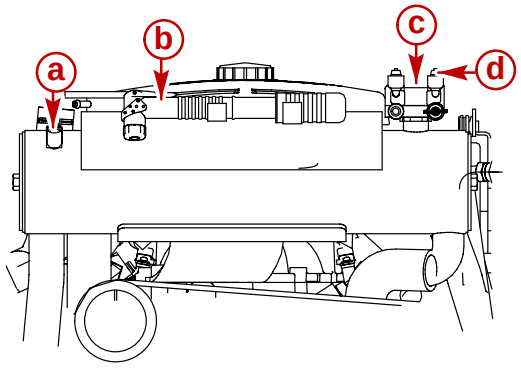
1. Remove the blue air pump from the engine.
2. Ensure that lever on top of pump is flush with the handle (horizontal).
3. Install the air pump on the fitting in the air manifold.



77638

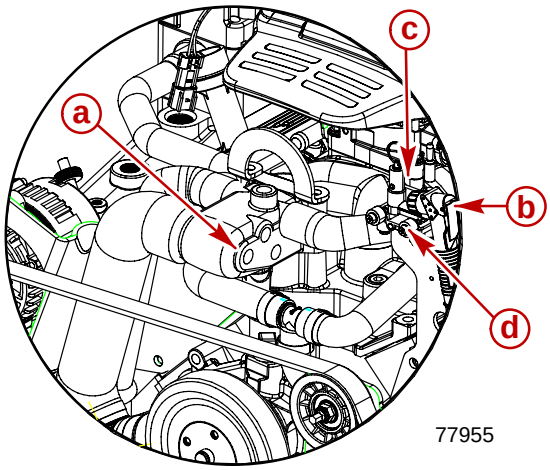
a - Green indicators

4. Pull the lever on the air pump up (vertical) to lock the pump on the fitting.
5. Pump air into the system until both green indicators extend and water drains from both sides of the engine. The port side will begin draining before the starboard side.



77955

Closed cooled models

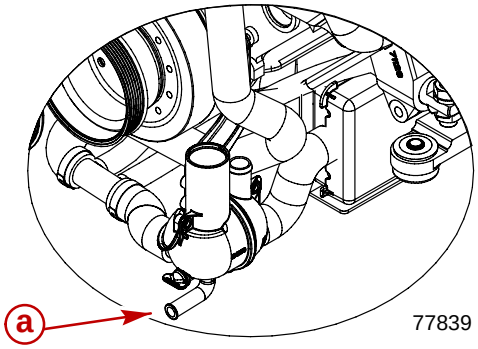


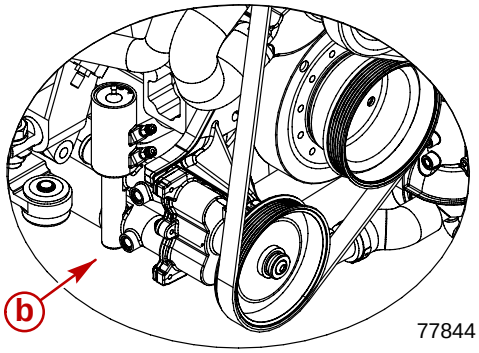
77955

Seawater cooled models

a - Blue drain plug location
b - Blue air pump
c - Air manifold
d - Green indicators

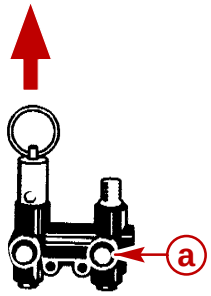
6. Verify that water is draining from each opening. If not, use the 3 Point Manual Drain System.





a - Port side drain location
b - Starboard side drain location

7. Allow the system to drain for a minimum of 5 minutes. Add air as necessary to keep the green indicators extended.
8. Crank engine over slightly with starter motor to purge any water trapped in seawater pump. Do not allow engine to start.
9. Remove the air pump from the air manifold and return it to the mounting bracket.
10. Mercury MerCruiser recommends leaving the plugs out while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.
11. Before launching boat, pull up on the manual release valve. Verify that the green indicators are no longer extended.

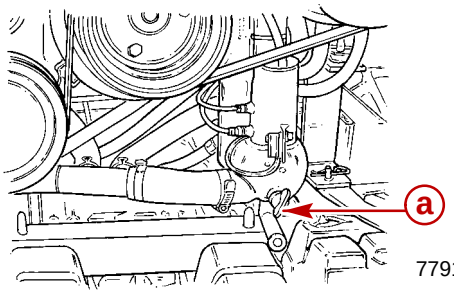


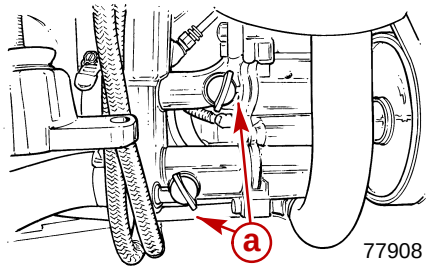
77638

a - Green indicators

3 POINT MANUAL DRAIN SYSTEM

1. Remove three blue drain plugs: 1 from the distribution housing (lower front, port side) and 2 from the seawater pickup pump (front, starboard side).





a - Blue drain plug

2. Verify that water is draining from each opening.
3. Allow the system to drain for a minimum of 5 minutes. Mercury MerCruiser recommends leaving the plugs out while transporting the boat or while performing other maintenance. This helps ensure that all water is drained.
4. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. Do not allow engine to start.
5. Prior to launching boat or starting the engine, close the drain system by re-installing the 3 blue drain plugs.

7 POINT MANUAL DRAIN SYSTEM

NOTE: *This procedure will not work with 3.0L Single Point Drain System. See specific instructions later in this manual.*

⚠ CAUTION

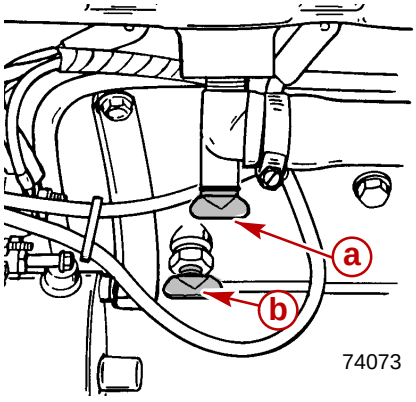
If boat is to remain in water after draining, seawater inlet hose must be removed and plugged to prevent a siphoning action that may occur, allowing seawater to flow from the drain holes or removed hoses.

IMPORTANT: Boat must be as level as possible to ensure complete draining of cooling system.

⚠ CAUTION

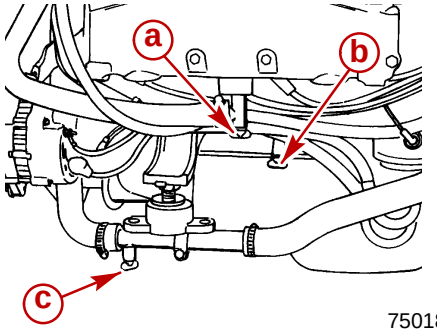
Seawater section of cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exists. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine. Damage caused by freezing IS NOT covered by the Mercury MerCruiser Limited Warranty.

1. Ensure that the engine is as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs from the following locations, if equipped:



74073

Starboard side

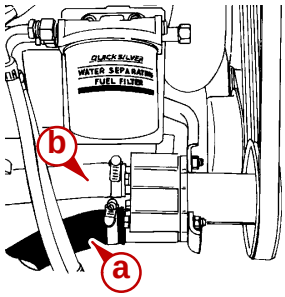


75018

Port side

a - Exhaust elbow drain plug
b - Cylinder block drain plug
c - Water tube drain plug

3. Remove seawater pump inlet hose.



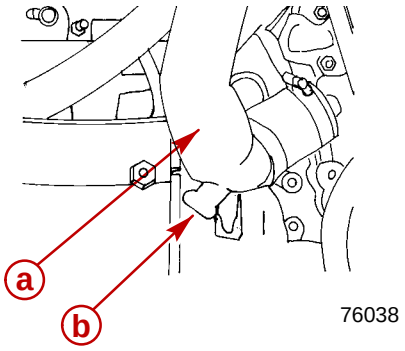
75533

a - Seawater inlet hose
b - Hose to cooler

4. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. Do not allow engine to start.
5. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift or bend hoses to allow water to drain completely.*

6. Remove the engine water circulating pump hose or drain plug, if equipped.
7. For sterndrive models, ensure that the gear housing water vent and drain holes, speedometer pitot hole, and trim tab cavity vent and drain holes are open and unobstructed.



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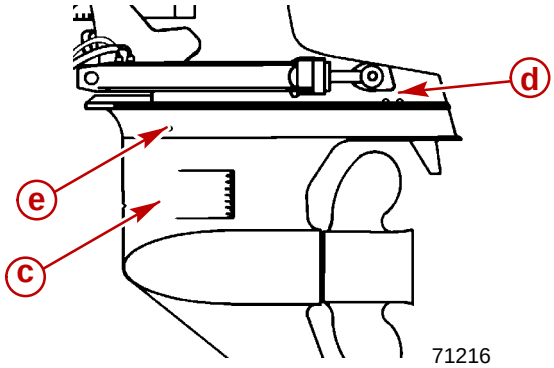

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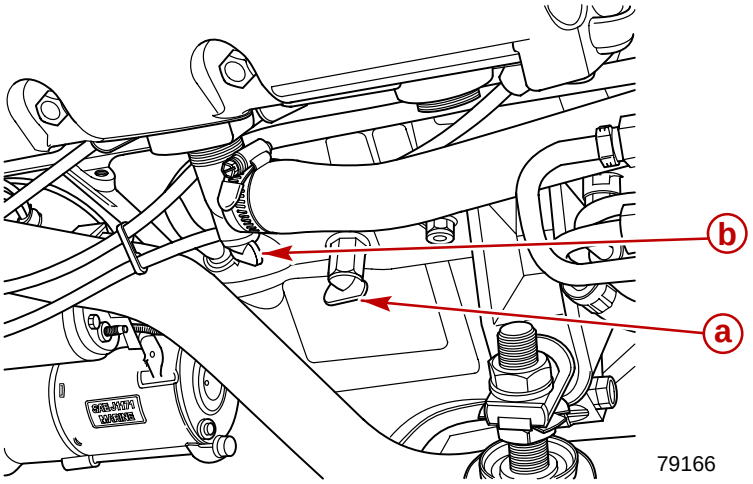
a - Water circulating pump hose
b - Drain plug
c - Gear housing water vent holes
d - Speedometer pitot holes
e - Trim tab cavity vents and drain holes

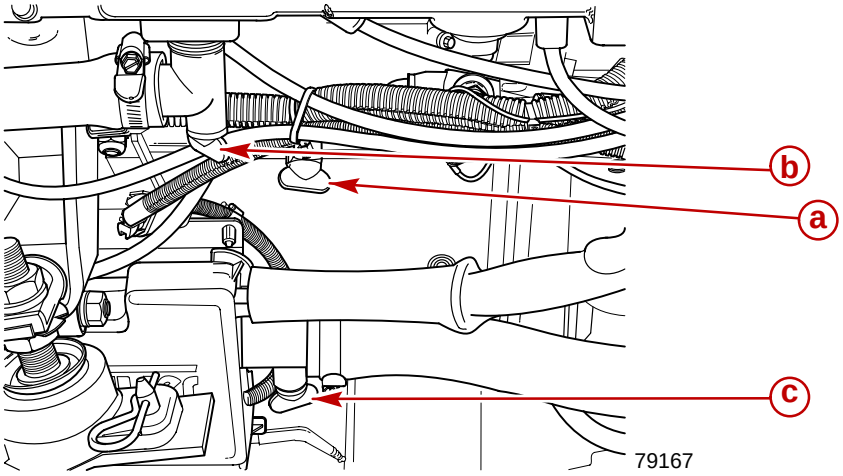
8. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. Do not allow engine to start.
9. After cooling system has been drained completely, install drain plugs, reconnect hoses, and tighten all hose clamps securely.
10. For additional assurance against freezing and rust, fill the cooling system with a mixture of propylene glycol and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage.
    a. Remove thermostat housing or hose and fill with coolant until he engine block and the cylinder head are full. If thermostat housing was removed, reinstall and tighten cover bolts securely.
    b. Remove water hose from exhaust manifold and fill manifold with coolant. Reinstall hose and tighten clamp securely.
11. For sterndrive models, store boat with sterndrive unit in full DOWN/IN position.

MULTI-POINT DRAIN (MPD) SYSTEM

1. Place the boat on a level surface to ensure complete draining of system.
2. Remove blue drain plugs from the following locations. It may be necessary to clean out drain holes using a stiff piece of wire. Do so until the entire system is drained.
   a. Port and starboard side of cylinder block.
   b. Bottom of exhaust manifolds.
   c. Fuel cooler.



Starboard side

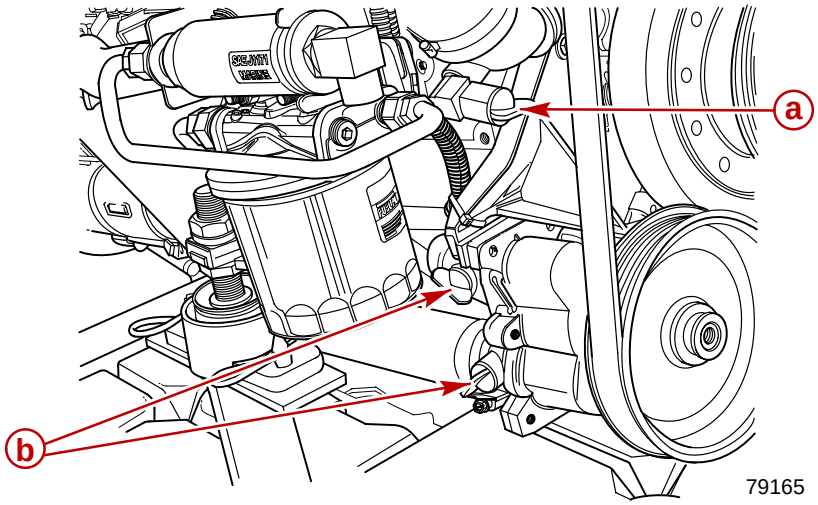


Port side

a - Side of cylinder block
b - Bottom of exhaust manifold
c - Fuel cooler

d. Water circulating pump hose.

e. Seawater pump.



a - Water circulating pump hose
b - Seawater pump

3. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. Do not allow engine to start.
4. After cooling system has been drained completely, install drain plugs, reconnect hoses and tighten all hose clamps securely.

   IMPORTANT: Mercury MerCruiser recommends that propylene glycol (a nontoxic and environmentally safe) antifreeze be used in the seawater section of the cooling system for cold weather or extended storage. Ensure that the propylene glycol anti-freeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

Power Package Recommissioning

1. Ensure that all cooling system hoses are connected properly and hose clamps are tight.

⚠ CAUTION

When installing the battery, connect the NEGATIVE (–) battery cable to the NEGATIVE (–) battery terminal and the POSITIVE (+) battery cable to the POSITIVE (+) battery terminal. If the battery cables are reversed, electrical system damage will result.

2. Install a fully-charged battery. Clean the battery cable clamps and terminals and reconnect cables (see CAUTION listed above). Tighten each cable clamp securely when connecting.
3. Coat the terminal connections with a battery terminal sealant.

Description	Where Used	Part Number
Battery terminal sealant	Battery terminals	Obtain locally

4. Perform all the checks in the BEFORE STARTING column of the Operations Chart.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

5. Start the engine and closely observe instrumentation to ensure that all systems are functioning correctly.
6. Carefully inspect the engine for fuel, oil, fluid, water, and exhaust leaks.
7. Inspect the steering system, shift, and throttle control for proper operation.

NOTES:

IMPORTANT INFORMATION

Section 1C - Troubleshooting

1 C

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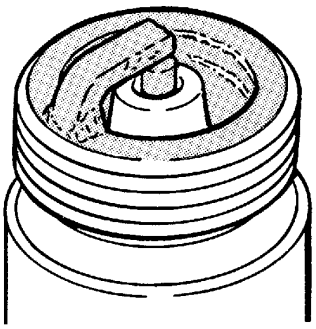
Used Spark Plug Analysis

Spark plug condition can suggest a variety of possible engine malfunctions and indicate needed engine repairs. When the old plugs are replaced, replace the entire set. Perform plug service only on those plugs suitable for additional service using the following procedures:

1. Remove any oil deposits with solvent and dry plugs thoroughly.
2. Open the electrode gap wide enough to permit cleaning and filing.
3. Remove the combustion deposits from the firing end of the spark plug with a plug cleaner. Use compressed air to remove abrasives.
4. File the electrode surfaces to restore clean, sharp edges. Remove filings with compressed air.
5. Reset the gap to specifications by bending only the side electrode with the proper tool.

Normal Condition

Few deposits are present and probably will be light tan or gray in color. This plug shows that the plug heat range is compatible with the engine, and the engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file, and regap), this plug can be reinstalled with good results.



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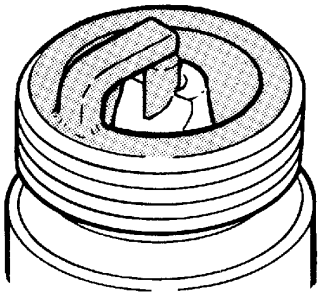
Chipped Insulator

A chipped insulator usually results from careless plug regapping. Under certain conditions, severe detonation also can split the insulator firing ends. Replace the spark plugs.

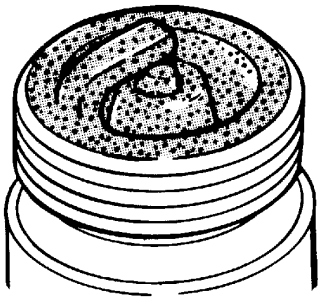


72420

Wet Fouling (Oil Deposits)

The plug becomes shorted by excessive oil entering the combustion chamber, usually in the engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering the combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

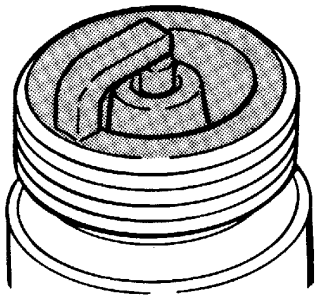
IMPORTANT: New engines or recently overhauled engines may wet foul the plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file, and regap) and reinstalled.



72420

Cold Fouling

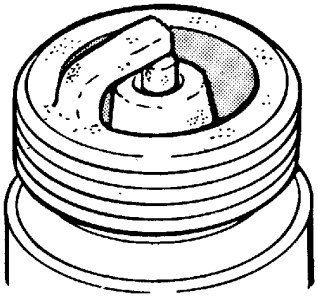
Dry, black deposits indicate a rich fuel mixture or a weak ignition. A clogged flame arrestor, a flooding engine, a sticky choke, or weak ignition components all are probable causes. If, however, only 1 or 2 plugs in the set are fouled, check for sticking valves or bad ignition leads. After correcting the cause, service (clean, file, and regap) plugs and reinstall.



72421

Overheating

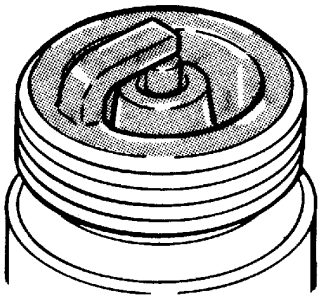
The insulator is dull white or gray and appears blistered. The electrodes are eroded and there is an absence of deposits. Ensure that the correct plug heat range is being used. Also check for incorrect rotor location, cooling system malfunction, lean fuel/air mixtures, leaking intake manifold, or sticking valves. Replace the spark plugs.



72421

High Speed Glazing

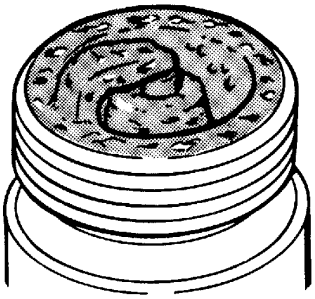
The insulator has yellowish, varnish-like color, indicating that the temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace the spark plugs. If the condition recurs, use colder heat range plug and service plugs more frequently.



72421

Scavenger Deposits

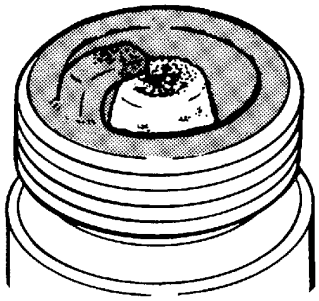
Powdery white or yellow deposits are built up on the shell, the insulator, and the electrodes. This is the normal appearance with certain branded fuels. Accumulation on the ground electrodes and the shell areas may be unusually heavy, but may be easily chipped off. Service (clean, file, and regap) plugs and reinstall.



72422

Pre-Ignition Damage

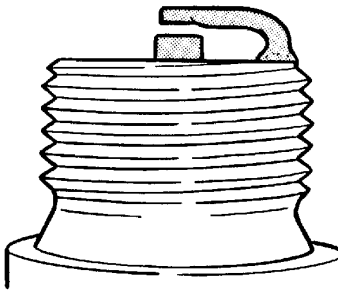
Pre-ignition damage is caused by excessive high temperatures. The center electrode melts first, followed by the ground electrode. Normally, the insulators are white, but may be dirty if the plug has been misfiring. Check for the correct plug heat range, incorrect rotor location, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold, or lack of lubrication. Replace the spark plugs.



72422

Reversed Coil Polarity

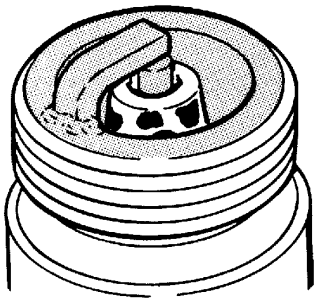
Concave erosion of the ground electrode is an indication of reversed polarity. The center electrode will show only normal wear. The engine will misfire and idle rough. To correct, reverse the primary coil leads. Replace the spark plugs.



72422

Splashed Deposits

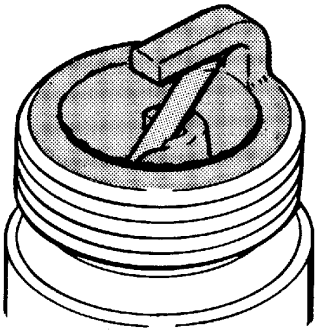
Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon the installation of the new plugs, the deposits loosen from the top of the piston and the cylinder head and are thrown against the hot insulator. Service (clean, file, and regap) plugs and reinstall.



72423

Mechanical Damage

Mechanical damage to the spark plug firing end is caused by a foreign object in the combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, the intake manifold and the exhaust material to prevent further damage. Replace the spark plugs.



72423

IMPORTANT: When working on the engine, the spark plug holes, the intake and the throttle body should be kept covered to prevent foreign objects from entering the combustion chamber.

Poor Boat Performance And/Or Poor Maneuverability

Symptom	Cause	Action
1. Bow too low	**1.0** Improper drive unit trim angle	**1.0** Trim the drive to the appropriate angle.
	1.1 Improper weight distribution	**1.1** Distribute the weight evenly.
	1.2 The boat is underpowered	**1.2** Replace propeller. If the problem persists, contact the manufacturer regarding the correct power package.
	1.3 Permanent or power hook in the boat bottom	**1.3** Correct the boat bottom.
	1.4 False bottom full of water	**1.4** Siphon the water from the false bottom. Determine the cause of the excess water.
	1.5 Improperly adjusted trim tabs or after planes	**1.5** Adjust the trim tabs or after planes
	1.6 Marine growth on boat bottom	**1.6** Clean the boat bottom.
2. Bow too high	**2.0** Improper drive unit trim angle	**2.0** Trim the drive to the appropriate angle.
	2.1 Propeller pitch too high	**2.1** Replace with a lower pitch propeller.
	2.2 Marine growth on boat bottom	**2.2** Clean the boat bottom.
	2.3 Poorly operating engine	**2.3** Tune the engine.
	2.4 Improper weight distribution	**2.4** Distribute the weight evenly.
	2.5 Rocker in the boat bottom	**2.5** Correct the boat bottom.
	2.6 False bottom full of water	**2.6** Siphon the water from the false bottom. Determine the cause of the excess water.
	2.7 Improperly adjusted trim tabs or after planes	**2.7** Adjust the trim tabs or after planes.

Poor Boat Performance And/Or Poor Maneuverability (continued)

Symptom	Cause	Action
3. Propeller ventilation	**3.0** Marine growth on boat bottom	**3.0** Clean the boat bottom.
	3.1 Damaged propeller, pitch too small, diameter too small	**3.1** Replace the propeller.
	3.2 Water pickup or through the hull fittings located too close to the propeller	**3.2** Remove the water pickup or the through the hull fittings. Repair the hull. Reinstall the water pickup or the through the hull fittings in the proper locations.
	3.3 Permanent or power hook in boat bottom	**3.3** Repair the boat bottom.
	3.4 Propeller plugged up with weeds	**3.4** Clean the propeller.
	3.5 Keel located too close to the propeller or too deep in the water	**3.5** Repair the hull.
	3.6 Drive unit installed too high on the transom	**3.6** Remove the drive unit. Repair the transom. Reinstall the drive unit in the proper position.

Improper Full Throttle Engine RPM

Symptom	Cause	Action
1. Full throttle engine rpm too high	**1.0** Propeller damaged, pitch too low, diameter too small, propeller hub slipping	**1.0** Replace the propeller.
	1.1 Water pickup or through the hull fittings located too close to the propeller.	**1.1** Remove the water pickup or the through the hull fittings. Repair the hull. Reinstall the water pickup or the through the hull fittings in the proper locations.
	1.2 Improper drive unit trim angle	**1.2** Trim the drive unit to the appropriate angle.
	1.3 Keel located too close to the propeller or too deep in the water	**1.3** Repair the hull.
	1.4 Drive unit installed too high on the transom	**1.4** Remove the drive unit. Repair the transom. Reinstall the drive unit in the proper position.
	1.5 Wrong gear ratio drive unit	**1.5** Replace the drive unit with the appropriate gear ratio.
2. Full throttle engine rpm too low	**2.0** Improper drive unit trim angle	**2.0** Replace the propeller.
	2.1 Drive unit trimmed in too far	**2.1** Trim the drive unit to the appropriate angle.
	2.2 Marine growth on boat bottom	**2.2** Clean the boat bottom.
	2.3 Damaged boat bottom	**2.3** Repair the boat bottom.
	2.4 Permanent or power hook in the boat bottom	**2.4** Repair the boat bottom.
	2.5 False bottom full of water	**2.5** Siphon the water from the false bottom. Determine the cause of the excess water.
	2.6 Drive unit installed too low on the transom	**2.6** Remove the drive unit. Reglass the transom and recut the hole. Reinstall the drive unit in the proper position.
	2.7 Wrong gear ratio drive unit	**2.7** Replace the drive unit with the appropriate gear ratio.

Engine Cranks Over But Will Not Start Or Starts Hard

Carbureted Important Information

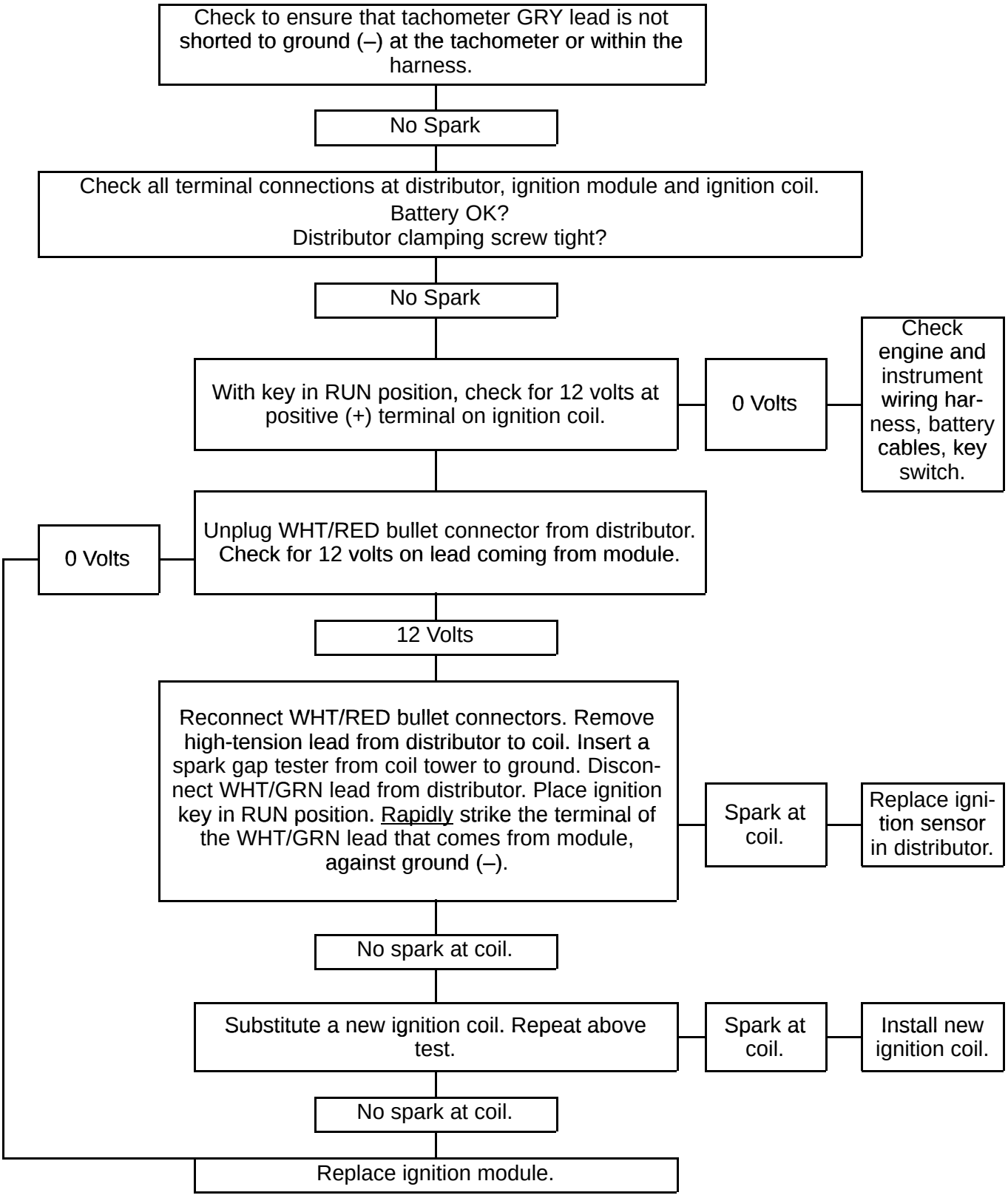
1. First, determine which engine system is causing the problem. To make an engine operate, basic components - fuel, spark (ignition), and compression - are required. If all 3 components are present, the engine should operate. If any 1 of the 3 are missing, weak, or arriving at the wrong time, the engine will not operate.
2. Determine if there is fuel present by looking down the carburetor venturi while actuating the throttle. There should be a stream of fuel coming out of the accelerator pump nozzles if the carburetor has fuel.
3. Check ignition system operation. Remove coil wire from tower on distributor cap. Hold coil wire near ground and check for spark while cranking engine over. Repeat procedure with spark plug wires. If there is spark at the spark plug wires, remove the spark plugs and ensure that they are the correct type and heat range, and not fouled or burned.
4. Run a compression check on engine to ensure that the engine is mechanically acceptable.

MPI Important Information

1. First, determine which engine system is causing the problem. To make an engine operate, basic components - fuel, spark (ignition), and compression - are required. If all 3 components are present, the engine should operate. If any 1 of the 3 are missing, weak, or arriving at the wrong time, the engine will not operate.
2. Determine if any faults are present by using a diagnostic tool. If faults are present, correct the fault before proceeding.
3. Determine if there is fuel present at the Schrader valve just behind the throttle body.
4. Remove the spark plugs and ensure that they are the correct type and heat range, and not fouled or burned.
5. Run a compression check on the engine to ensure that the engine is mechanically acceptable.

Testing Thunderbolt V Ignition System (Carbureted)

IMPORTANT: The WHT/GRN lead must be touched against ground (–) 2-3 times per second to simulate a running engine. Repeat this test several times to ensure that spark is present.



Engine Cranks Over But Will Not Start Or Starts Hard

Symptom	Cause	Action
1. Engine cranks over but will not start or starts hard	**1.0** Clogged flame arrestor	**1.0** Clean the flame arrestor.
	1.1 Excessive fuel pump pressure	**1.1** Determine the cause of the excess pressure and repair.
	1.2 Empty fuel tank	**1.2** Fill the fuel tank.
	1.3 Fuel shut off valve closed	**1.3** Open the fuel shut off valve.
	1.4 Vapor lock	**1.4** Refer to Vapor Lock Condition.
	1.5 Fuel system lean	**1.5** Clean fuel system.
	1.6 Low grade or stale fuel	**1.6** Drain the fuel tank and refill.
	1.7 Water in the fuel	**1.7** Treat the contaminated fuel with appropriate fuel treatment. If the problem persists, drain the fuel tank and refill.

Fuel System Rich (Carbureted)

Symptom	Cause	Action
1. Engine cranks over but will not start or starts hard	**1.0** Clogged flame arrestor	**1.0** Clean the flame arrestor.
	1.1 Excessive fuel pump pressure	**1.1** Determine the cause of the excess pressure and repair.
	1.2 Fuel boils out of float bowl when shut off and warm floods intake manifold.	**1.2** Refer to Engine Overheats Cooling section.
	1.3 Float leaks or is saturated with fuel	**1.3** Replace the float assembly.
	1.4 Needle and seat leaking	**1.4** Replace the needle and seat.
	1.5 Carburetor gaskets leaking	**1.5** Replace the carburetor gaskets.
	1.6 Cracked or porous carburetor body	**1.6** Replace the carburetor.

Fuel System Lean (Carbureted)

Symptom	Cause	Action
1. Engine cranks over but will not start or starts hard	**1.0** Clogged flame arrestor	**1.0** Clean the flame arrestor.
	1.1 Empty fuel tank	**1.1** Fill the fuel tank.
	1.2 Fuel shut off valve closed	**1.2** Open the fuel shut off valve.
	1.3 Vapor lock	**1.3** Refer to Vapor Lock Condition.
	1.4 Automatic choke stuck open, wrong adjustment	**1.4** Inspect the linkage. Adjust the choke.
	1.5 Low grade or stale fuel	**1.5** Drain the fuel tank and refill.
	1.6 Water in fuel	**1.6** Treat the contaminated fuel with appropriate fuel treatment. If the problem persists, drain the fuel tank and refill.
	1.7 Lanyard stop switch activated	**1.7** Deactivate the lanyard stop switch

Engine Will Not Crank Over

Symptom	Cause	Action
1. Engine will not crank over	**1.0** Remote control lever not in NEUTRAL position	**1.0** Place the remote control lever in NEUTRAL and try the ignition again. If the problem persists, check the remote control lever NEUTRAL detent setting.
	1.1 Battery charge low, damaged wiring, loose electrical connections	**1.1** Check the electrical connections at the starter. Check the battery cable connections. Check the battery charge and recharge if necessary.
	1.2 Circuit breaker tripped	**1.2** Reset the circuit breaker.
	1.3 Blown fuse	**1.3** Replace the fuse.
	1.4 Ignition switch faulty	**1.4** Replace the ignition switch.
	1.5 Slave solenoid faulty	**1.5** Replace the slave solenoid.
	1.6 Faulty neutral start safety switch	**1.6** Replace the neutral start safety switch.
	1.7 Starter solenoid faulty	**1.7** Replace the starter solenoid.
	1.8 Starter motor faulty	**1.8** Replace the starter motor.
	1.9 Mechanical engine malfunction	**1.9** Determine the cause of the malfunction and repair.
	1.10 Lanyard stop switch activated	**1.10** Deactivate-activate the lanyard stop switch

Charging System Inoperative

Symptom	Cause	Action
1. Charging system inoperative	**1.0** Loose or broken drive belt	**1.0** Replace the serpentine drive belt.
	1.1 Engine rpm too low on initial start	**1.1** Accelerate the engine to 1500 rpm.
	1.2 Loose or corroded electrical connections	**1.2** Check the electrical connections.
	1.3 Faulty battery gauge	**1.3** Replace the gauge.
	1.4 Battery will not accept charge	**1.4** Check the electrolyte level and fill if necessary. Replace the battery.
	1.5 Faulty alternator or regulator	**1.5** Test the alternator and the regulator and replace if necessary.

Noisy Alternator

Symptom	Cause	Action
1. Noisy alternator	**1.0** Loose mounting bolts	**1.0** Tighten the mounting bolts.
	1.1 Loose or broken drive belt	**1.1** Replace the serpentine drive belt.
	1.2 Loose drive pulley	**1.2** Tighten the drive pulley.
	1.3 Worn or dirty bearings	**1.3** Replace the bearings.
	1.4 Faulty diode trio or stator	**1.4** Replace the alternator.

Instrumentation Malfunction

Symptom	Cause	Action
1. Instrumentation Malfunction	**1.0** Faulty wiring, loose or corroded terminals	**1.0** Check the electrical connections.
	1.1 Faulty key switch	**1.1** Replace the key switch.
	1.2 Faulty gauge	**1.2** Replace the gauge.
	1.3 Faulty sender	**1.3** Replace the sender.

Radio Noise

Symptom	Cause	Action
1. A popping noise that will increase with engine rpm. Noise will stop as soon as engine is turned off	**1.0** Wrong spark plugs	**1.0** Change the spark plugs.
	1.1 Cracked distributor cap	**1.1** Check the distributor cap for cracks or marks. Replace the cap if necessary.
	1.2 Cracked coil tower	**1.2** Check the ignition coil for cracks or corrosion.
	1.3 Leaking spark plug wires	**1.3** Change the spark plug wires.
	1.4 Moisture on ignition components	**1.4** Check all ignition components for corrosion.
2. A high pitched whine in the radio	**2.0** Alternator - poor brush contact on the slip rings	**2.0** Test the alternator. Replace if necessary.
3. A hissing or crackling noise when instruments are jarred with ignition on	**3.0** Instrumentation - loose connections or antennae wire routed too close to instruments	**3.0** Check the instrument harness connections. Check the antennae routing.
4. Varying unexplained noises	**4.0** Accessories - bilge pump, bilge blower, fish finder, depth locator, cabin heater motor, etc.	**4.0** Disconnect the accessories one at a time until the noise disappears. Replace the faulty accessory.

Poor Fuel Economy

Symptom	Cause	Action
1.0 Poor fuel economy	**1.0** Fuel leak	**1.0** Locate the leak and repair.
	1.1 Operator habits - Prolonged idling, slow acceleration, failure to cut back on throttle once boat is on plane, boat overloaded, uneven weight distribution	**1.1** Educate the operator.
	1.2 Engine laboring - Bent, damaged or wrong propeller	**1.2** Water test the boat for proper operating rpm at WOT.
	1.3 Clogged flame arrestor	**1.3** Clean the flame arrestor.
	1.4 Engine compartment sealed too tight	**1.4** Vent the engine hatch appropriately.
	1.5 Boat bottom dirty (marine growth), hook, rocker	**1.5** Clean the boat bottom.
	1.6 Improper fuel	**1.6** Drain the fuel tank and refill with the correct fuel.
	1.7 Crankcase ventilation system clogged or dirty	**1.7** Clean the crankcase ventilation hoses.
	1.8 Engine needs tune-up	**1.8** Change the spark plugs.
		Check the distributor cap for cracks or marks. Replace the cap if necessary.
		Check the ignition coil for cracks or corrosion.
		Change the spark plug wires.
		Check all ignition components for corrosion.
	1.9 Engine running too cold or too hot	**1.9** Check the thermostat.
		Check for kinked or restricted hoses.
		Clean the cooling system.
	1.10 Plugged or restricted exhaust	**1.10** Clean the exhaust system.
	1.11 Low compression	**1.11** Perform the cylinder compression check to determine which cylinder has low compression.
		Replace the rings, the valves, or the pistons.
	1.12 Carburetor	**1.12** Check the idle mixture settings, accelerator pump adjustments, linkage binding, and choke adjustment, carburetor flooding over, main fuel jets clogged or improperly sized

Carburetor Malfunctions

Symptom	Cause	Action
1. Flooding	**1.0** Needle and seat broken or damaged	**1.0** Replace the needle and seat.
	1.1 Saturated float	**1.1** Replace the float.
	1.2 Gaskets leaking	**1.2** Replace the gaskets.
	1.3 Cracked fuel bowl	**1.3** Replace the fuel bowl.
	1.4 Fuel percolation	**1.4** Refer to Engine Overheats Cooling section.
	1.5 Automatic choke malfunctioning	**1.5** Inspect the linkage. Adjust the choke.
2. Rough idle	**2.0** Idle rpm too low	**2.0** Adjust the idle screw.
	2.1 Idle mixture screws improperly adjusted	**2.1** Adjust the idle mixture screw.
	2.2 Idle passages dirty	**2.2** Clear the idle passages.
	2.4 Engine flooding	**2.4** Check the ignition system for problems, correct if necessary. Check the idle mixture screw, adjust if necessary. Check the needle and seat, replace if necessary. Check the float level or drop, adjust if necessary.
	2.5 Vacuum leak	**2.5** Locate and repair the vacuum leak.
3. Hesitation or acceleration flatness	**3.0** Accelerator pump damaged, malfunctioning or improperly adjusted	**3.0** Replace the accelerator pump. Check for mechanical binding. Adjust the accelerator pump. Replace if necessary.
	3.1 Leaking gaskets	**3.1** Replace the gaskets.
	3.2 Automatic choke malfunctioning	**3.2** With engine running, check for power at the choke. If no power, find problem and repair. Check for mechanical binding. Adjust the linkage if necessary. Clean and adjust the choke.
	3.3 Power valve broken or improperly adjusted	**3.3** Replace the power valve.
	3.6 Main metering jets clogged or improperly sized	**3.5** Replace the main metering jets.

Engine Runs Poorly At Idle

Symptom	Cause	Action
1. Engine surges	**1.0** Leaking idle air control (IAC), intake manifold, throttle body gaskets, or carburetor gaskets	**1.0** Find and replace the leaking gaskets.
	1.1 Throttle valves worn or damaged	**1.1** Inspect the throttle valves. Replace the throttle body if necessary.
	1.2 Worn or leaking IAC hose or vacuum hose to the pressure regulator	**1.2** Find and replace the leaking hose.
	1.3 Main metering jets clogged or improperly sized	**1.3** Replace the main metering jets.
	1.4 Float adjustment	**1.4** Adjust the float.
	1.5 Saturated float	**1.5** Replace the float.
	1.6 Power valve broken or improperly adjusted	**1.6** Replace the power valve.
2. Low top speed or lack of power	**2.0** Leaking idle air control (IAC), intake manifold, throttle body gaskets, or carburetor gaskets	**2.0** Find and replace the leaking gaskets.
	2.1 Power valve broken or improperly adjusted	**2.1** Replace the power valve.
	2.2 Float adjustment	**2.2** Adjust the float.
	2.3 Main metering jets clogged or improperly sized	**2.3** Replace the main metering jets.
3. Poor cold engine operation	**3.0** Engine is not reaching normal operating temperature	**3.0** Replace the thermostat or the thermostat housing gasket.
	3.1 Faulty engine temperature sensor (ECT)	**3.1** Replace the ECT.
	3.2. Fuel pressure too high or too low	**3.2** Determine the cause and repair.
	3.3 Throttle valves worn or damaged	**3.3** Inspect the throttle valves. Replace the throttle body if necessary.

Engine Runs Poorly At Idle (continued)

Symptom	Cause	Action
3. Poor cold engine operation (continued)	**3.4** Engine flooding (MPI)	**3.4** Check the fuel pressure. If too high, find cause and correct. Clean the flame arrestor. Perform the cylinder balance test.
	3.5 Engine flooding (carbureted)	**3.5** Check the ignition system for problems. Correct if necessary. Check the idle mixture screw. Adjust if necessary. Check the needle and seat. Replace if necessary. Check the float level or drop. Adjust if necessary.
	3.6 Idle rpm too low	**3.6** Adjust the idle screw.
	3.7 Idle mixture screw improperly adjusted	**3.7** Adjust the idle mixture screw.
	3.8 Automatic choke malfunctioning	**3.8** With engine running, check for power at the choke. If no power, find problem and repair. Check for mechanical binding. Adjust the linkage if necessary. Clean and adjust the choke.
4. Engine stalls	**4.0** Idle rpm too low	**4.0** Clean the flame arrestor. Test the IAC to see if it opens and closes properly.
	4.1 Idle mixture screw improperly adjusted	**4.1** Adjust the idle mixture screw. Adjust idle screw.
	4.2 Engine flooding (MPI)	**4.2** Check the fuel pressure. If too high, find cause and correct. Inspect the fuel pressure regulator. Inspect the injectors.
	4.3 Engine flooding (carbureted)	**4.3** Check the ignition system for problems. Correct if necessary. Check the idle mixture screw. Adjust if necessary. Check the needle and seat. Replace if necessary. Check the float level or drop. Adjust if necessary.

Engine Runs Poorly At Idle (continued)

Symptom	Cause	Action
4. Engine stalls (continued)	**4.4** Automatic choke malfunctioning	**4.4** With engine running, check for power at the choke. If no power, find problem and repair. Check for mechanical binding. Adjust the linkage if necessary. Clean and adjust the choke.
	4.5 Accelerator pump damaged, malfunctioning or improperly adjusted	**4.5** Replace the accelerator pump. Check for mechanical binding. Adjust the accelerator pump. Replace if necessary
	4.6 Dirt in carburetor	**4.6** Clean the carburetor.
	4.7 Leaking idle air control (IAC), intake manifold, throttle body gaskets or carburetor gaskets.	**4.7** Find and replace the leaking gaskets.
5. Engine misses	**5.0** Fault in the ignition system	**5.0** Check the spark plugs. Check the spark plug wires. Check the distributor cap for cracks or marks. Check the ignition coil operation. Replace the faulty component.
6. Hard starting	**6.0** Engine starts hard	**5.0** Refer to Engine Starts Hard.

Engine Runs Poorly At High RPM

Symptom	Cause	Action
1. Engine runs poorly at high rpm	**1.0** Crankcase overfilled with oil	**1.0** Check the oil level with the boat at rest in the water. Drain the oil if necessary to obtain the correct level.
	1.1 Anti-siphon valve restricting fuel supply	**1.1** Check the fuel flow rates and repair, replace or remove anti-siphon valve as necessary.
	1.2 Plugged fuel tank vent	**1.2** Clean the fuel tank vent.
	1.3 Improper fuel supply	**1.3** Inspect the fuel supply system. Repair or replace as necessary.
	1.4 Incorrect rotor location	**1.4** Reset the rotor location.
	1.5 Incorrect ignition timing	**1.5** Check the ignition timing. Adjust if necessary

Engine Runs Poorly At High RPM (continued)

Symptom	Cause	Action
1. Engine runs poorly at high rpm (continued)	**1.6** Low grade or stale fuel	**1.6** Drain the fuel tank and refill.
	1.7 Water in the fuel	**1.7** Treat the contaminated fuel with appropriate fuel treatment. If the problem persists, drain the fuel tank and refill.
	1.8 Spark plugs fouled, burned, cracked porcelain, or incorrect heat range	**1.8** Inspect the spark plugs and service or replace.
	1.9 Spark plug wires broken or poorly insulated	**1.9** Replace the spark plug wires.
	1.10 Distributor cap or rotor dirty or cracked	**1.10** Inspect the distributor cap for cracks or marks. Replace the distributor cap and the rotor if necessary.
	1.11 Coil damaged or malfunctioning	**1.11** Replace the coil.
	1.12 Excessive play in distributor shaft	**1.12** Replace the distributor.
	1.13 Engine overheating	**1.13** Check cooling water supply or coolant level.
	1.14 Low compression – worn valves, rings or seals	**1.14** Perform the cylinder compression check to determine which cylinder has low compression. Replace the rings, valves or pistons.
	1.15 Plugged or restricted exhaust	**1.15** Clean the exhaust system.

Engine Acceleration Is Poor

Symptom	Cause	Action
1. Engine acceleration is poor	**1.0** Incorrect rotor location	**1.0** Reset rotor location.
	1.1 Incorrect distributor or amplifier advance curve	**1.1** Replace ECM.
	1.2 Distributor cap or rotor dirty or cracked	**1.2** Inspect the distributor cap for cracks or marks. Replace the distributor cap and the rotor if necessary.
	1.3 Vacuum leak	**1.3** Locate and repair the vacuum leak.
	1.4 Spark plugs fouled, burned, cracked porcelain, or incorrect heat range	**1.4** Inspect the spark plugs and service or replace.
	1.5 Low compression – worn valves, rings, or seals	**1.5** Perform the cylinder compression check to determine which cylinder has low compression. Replace the rings, valves or pistons.
	1.6 Idle mixture screw improperly adjusted	**1.6** Adjust the idle mixture screw.
	1.7 Incorrect ignition timing	**1.7** Check the ignition timing. Adjust if necessary
	1.8 Accelerator pump damaged, malfunctioning, or improperly adjusted	**1.8** Replace the accelerator pump. Check for mechanical binding. Adjust the accelerator pump. Replace if necessary
	1.9 Float adjustment	**1.9** Check float level or drop. Adjust if necessary.
	1.10 Dirty carburetor	**1.10** Clean the carburetor.

Troubleshooting With Vacuum Gauge

Symptom	Cause	Action
1. Steady reading between 38.1-53.3 cm (15-21 in.) at idle rpm	**1.0** Normal	**1.0** No action necessary.
2. Extremely low reading, but steady at idle rpm	**2.0** Vacuum leak, incorrect rotor location, underpowered boat, faulty boat bottom	**2.0** Determine the source of the vacuum leak and repair. Remove and reinstall the distributor. Replace the propeller. If the problem persists, contact the manufacturer about the correct power package. Repair the boat bottom.
3. Fluctuates between high and low at idle rpm	**3.0** Blown cylinder head gasket between two adjacent cylinders	**3.0** Determine the cause and replace the cylinder head gasket.
4. Fluctuates 10.1-12.7 cm (4-5 in.) very slowly at idle rpm	**4.0** Spark plug gap too narrow	**4.0** Inspect the spark plugs and service or replace if necessary. Check carburetor adjustment.
5. Fluctuates rapidly at idle, steadies as rpm is increased	**5.0** Valve guides are worn	**5.0** Ream the valve guides and install a valve with an oversized stem or replace the cylinder head.
6. Continuously fluctuates between low and normal reading at regular intervals at idle rpm	**6.0** Burned or leaking valve	**6.0** Replace the valve.

Engine Noise

Important Information

No definite rule or test will positively determine the source of engine noise. Use the following information only as a general guide to engine noise diagnosis.

1. Use a timing light to determine if the noise is timed with engine speed or 1/2 engine speed. Noises timed with engine speed are related to the crankshaft, rods, pistons, piston pins, and flywheel. Noises timed to 1/2 engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source; however, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe the noise is confined to one particular cylinder, ground spark plug leads one at a time. If the noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to a location in the engine: front to back, top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: the flywheel or coupler; the exhaust flappers rattling against exhaust pipe; the crankshaft striking the oil pan, oil pan baffle or dipstick tube; the rocker arm striking the valve cover or a loose flywheel cover. In many cases, if this is found to be the problem, a complete engine teardown is not necessary.
6. When the noise is isolated to a certain area and component, removal and inspection will be required. Refer to the appropriate sections of the service manual for the information required for service.
7. If the noise cannot be distinguished between the engine and the drive unit, remove the drive from the boat. Supplying water directly to the engine, operate the engine without the drive to determine whether the noise still occurs.

Engine Noise (continued)

Symptom	Cause	Action
1. Engine noise in the valve cover area, timed to 1/2 engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders	**1.0** Rocker arm striking cover	**1.0** Inspect the valve cover for damage. Replace if necessary.
	1.1 Rocker arm out of adjustment	**1.1** Adjust the rocker arm.
	1.2 Worn rocker arm	**1.2** Replace the rocker arm.
	1.3 Bent push rod	**1.3** Replace the push rods.
	1.4 Collapsed lifter	**1.4** Replace the lifter.
2. Engine noise in cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed	**2.0** Sticking valve	**2.0** Inspect the valves and repair or replace.
	2.1 Carbon build-up	**2.1** Inspect the internal engine components for carbon buildup. Clean or replace.
	2.2 Connecting rod installed wrong	**2.2** Remove the connecting rods and install properly.
	2.3 Bent connecting rod	**2.3** Replace the connecting rod.
	2.4 Piston damaged or broken	**2.4** Inspect the piston. Replace if necessary.
	2.5 Piston rings damaged or broken	**2.5** Inspect the piston rings. Replace if necessary.
	2.6 Piston pin damaged or broken	**2.6** Inspect the piston pin. Replace if necessary.
	2.7 Worn cylinder	**2.7** Inspect the cylinder. Bore as necessary. Replace the cylinders if necessary.
3. Engine noise in camshaft area, front of the engine, timed to 1/2 engine speed	**3.0** Crankshaft timing sprocket damaged	**3.0** Inspect the crankshaft timing sprocket. Replace if necessary.
	3.1 Timing chain damaged	**3.1** Inspect the timing chain. Replace if necessary.
	3.2 Fuel pump damaged	**3.2** Inspect the fuel pump. Replace if necessary.
	3.3 Valve lifter damaged	**3.3** Inspect the valve lifter. Replace if necessary.
	3.4 Camshaft bearings damaged	**3.4** Inspect the cam bearings. Replace if necessary.

Engine Noise (continued)

Symptom	Cause	Action
4. Engine noise in camshaft area, center of the engine, timed to 1/2 engine speed	**4.0** Fuel pump damaged	**4.0** Inspect the fuel pump. Replace if necessary.
	4.1 Valve lifter damaged	**4.1** Inspect the valve lifter. Replace if necessary.
	4.2 Camshaft bearing damaged	**4.2** Inspect the camshaft bearings. Replace if necessary.
5. Engine noise in camshaft area, rear of the engine, timed to 1/2 engine speed	**5.0** Distributor gear damaged	**5.0** Inspect the distributor gear. Replace if necessary.
	5.1 Valve lifter damaged	**5.1** Inspect the valve lifter. Replace if necessary.
	5.2 Camshaft bearings damaged	**5.2** Inspect the camshaft bearings. Replace if necessary.
6. Engine noise in camshaft area, throughout the engine, timed to 1/2 engine speed	**6.0** Loss of oil pressure	**6.0** Check the crankcase oil level. If low, fill the crankcase and determine the cause of the oil loss. Check for leaks. Check the oil pressure gauge operation. Check the oil pump operation.
	6.1 Valve lifters damaged	**6.1** Inspect the valve lifters. Replace if necessary.
	6.2 Camshaft bearings damaged	**6.2** Inspect the camshaft bearings. Replace if necessary.

Engine Noise (continued)

Symptom	Cause	Action
7. Engine noise in crankshaft area, front of the engine, timed to engine speed	**7.0** Crankshaft timing sprocket damaged	**7.0** Inspect the crankshaft timing sprocket. Replace if necessary.
	7.1 Timing chain damaged	**7.1** Inspect the timing chain. Replace if necessary.
	7.2 Main bearing damaged	**7.2** Inspect the main bearing. Replace if necessary.
	7.3 Rod bearing damaged	**7.3** Inspect the rod bearing. Replace if necessary.
8. Engine noise in crankshaft area, center of the engine, timed to engine speed	**8.0** Crankshaft striking the oil pan or the oil pan baffle	**8.0** Inspect the oil pan and the oil pan baffle. Repair or replace as necessary.
	8.1 Main bearing damaged	**8.1** Inspect the main bearing. Replace if necessary.
	8.2 Rod bearing damaged	**8.2** Inspect the rod bearing. Replace if necessary.
9. Engine noise in crankshaft area, rear of the engine, timed to engine speed	**9.0** Loose flywheel cover	**9.0** Tighten the flywheel cover fasteners.
	9.1 Loose coupler	**9.1** Tighten the coupler fasteners.
	9.2 Loose flywheel	**9.2** Tighten the flywheel fasteners.
	9.3 Main bearing damaged	**9.3** Inspect the main bearing. Replace if necessary.
	9.4 Rod bearing damaged	**9.4** Inspect the rod bearing. Replace if necessary.
10. Engine noise in the crankshaft area, throughout the engine, timed to engine speed	**10.0** Loss of oil pressure	**10.0** Check the crankcase oil level. If low, fill the crankcase and determine the cause of the oil loss. Check for leaks. Check the oil pressure gauge operation. Check the oil pump operation.
	10.1 Main bearings damaged	**10.1** Inspect the main bearing. Replace if necessary.
	10.2 Rod bearings damaged	**10.2** Inspect the rod bearing. Replace if necessary.

Engine Noise (continued)

Symptom	Cause	Action
11. Engine spark knock	**11.0** Advanced timing	**11.0** Replace the ECM.
	11.1 Low grade or stale fuel	**11.1** Drain the fuel tank and refill.
	11.2 Engine overheating	**11.2** Check cooling water supply or coolant level.
	11.3 Carbon build-up	**11.3** Inspect the internal engine components for carbon buildup. Clean or replace.
12. Hissing	**12.0** Vacuum leak	**12.0** Locate and repair the vacuum leak.
	12.1 Leaking exhaust (manifolds or pipes)	**12.1** Inspect the exhaust manifolds and elbows for cracks or porosity. Replace the gaskets.
	12.2 Loose cylinder heads	**12.2** Ensure that the cylinder head bolts are properly torqued. Replace the bolts if necessary.
	12.3 Blown cylinder head gasket	**12.3** Determine the cause of blown gasket and replace the gasket.
13. Throttle Body Whistle	**13.0** Vacuum leak	**13.0** Locate and repair the vacuum leak.
	13.1 Dry or tight bearing in an accessory	**13.1** Locate the bearing and lubricate or replace.
	13.2 IAC muffler misaligned or missing.	**13.2** Install new muffler or realign.
14. Sparks jumping	**14.0** Leaking high tension lead	**14.0** Replace the high tension lead.
	14.1 Cracked coil tower	**14.1** Replace the ignition coil.
	14.2 Cracked distributor cap	**14.2** Replace the distributor cap.
15. Squeaks or squeals	**15.0** Drive belt slipping	**15.0** Replace the drive belt.
	15.1 Dry or tight bearing in an accessory	**15.1** Locate the bearing and lubricate or replace.
	15.2 Parts rubbing together	**15.2** Locate the parts and correct the cause.

Engine Noise (continued)

Symptom	Cause	Action
16. Rattling in the exhaust pipe area	**16.0** Exhaust shutters damaged	**16.0** Inspect the exhaust shutters for damage. Replace if necessary.
17. Popping through the carburetor	**17.0** Incorrect ignition timing	**17.0** Adjust the ignition timing.
	17.1 Carburetor set too lean	**17.1** Adjust the idle mixture screw.
	17.2 Faulty accelerator pump	**17.2** Replace the accelerator pump.
	17.3 Vacuum leak	**17.3** Locate and repair the vacuum leak.
	17.4 Valve adjustment	**17.4** Adjust the valves.
	17.5 Valve timing incorrect	**17.5** Adjust the valves.
	17.6 Burned or stuck valve	**17.6** Repair or replace as necessary.

Oil Pressure

Symptom	Cause	Action
1. Loss of engine rpm, oil pressure gauge fluctuation, drop in oil pressure, and hydraulic valve lifter noise at high rpm	**1.0** Oil level in the crankcase above the FULL or OK RANGE mark	**1.0** Drain excess oil.
2. Low oil pressure, oil pressure gauge fluctuation, internal engine noise and/or damage	**2.0** Oil level in the crankcase below the ADD mark	**2.0** Add oil to the correct level. Determine if engine noise is still present and if so, diagnose internal engine damage.
3. Change in oil pressure	**3.0** This may be a normal condition. Oil pressure may be high in the cooler times of the day and when the engine is not up to operating temperature. As the air temperature warms up and the engine is operating at normal temperature, it is normal for oil pressure to drop.	**3.0** Check oil level. If oil level is accurate and oil pump appears to be working, no further action is necessary.
4. Low engine oil pressure at idle	**4.0** With modern engines and engine oils, low oil pressure readings at idle do not necessarily mean there is a problem. If valve lifters do not clatter (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and the oil will thin out somewhat from heat.	**4.0** Check oil level. Add if necessary. Listen for engine noise. If no noise is present, no further action is necessary.
5. Low engine oil pressure at idle after operating at a high rpm	**5.0** With modern engines and engine oils, low oil pressure readings at idle do not necessarily mean there is a problem. If valve lifters do not clatter (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and the oil will thin out somewhat from heat.	**5.0** Check oil level. Add if necessary. Listen for engine noise. If no noise is present, no further action is necessary.

Oil Pressure (continued)

Symptom	Cause	Action
6. Differences in oil pressure between engines on boats with dual engines	**6.0** It is not uncommon to see different oil pressure readings between the two engines, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, or other differences.	**6.0** Check oil level. Add if necessary. Listen for engine noise. If no noise is present, no further action is necessary.
7. Differences in oil pressure between stations on boats with dual stations	**7.0** It is not uncommon to see different oil pressure readings between the two stations, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, or other differences.	**7.0** Check oil level. Add if necessary. Listen for engine noise. If no noise is present, no further action is necessary.
8. Low oil pressure	**8.0** Low oil level in crankcase	**8.0** Check the oil level with the dipstick. Add oil as necessary.
	8.1 Defective oil pressure gauge and/or sender	**8.1** Verify with an automotive test gauge.
	8.2 Thin or diluted oil	**8.2** Change the oil.
	8.3 Faulty oil pump	**8.3** Ensure that the relief valve opens and closes properly.
		Check the pickup tube for restrictions.
		Rebuild or replace the oil pump.
	8.4 Internal or external oil leak	**8.4** Check for oil passage plugs leaking.
		Check the cylinder block for cracks.
	8.5 Excessive bearing clearance	**8.5** Inspect bearings and replace if necessary.
9. High oil pressure	**9.0** Oil too thick	**9.0** Change the oil.
	9.1 Defective oil pressure gauge and/or sender	**9.1** Verify with an automotive test gauge.
	9.2 Clogged or restricted oil passage	**9.2** Clean all oil passages.
	9.3 Oil pump relief valve stuck closed	**9.3** Repair or replace oil pump.

Excessive Oil Consumption

Symptom	Cause	Action
1. Excessive oil consumption	**1.0** Oil leaks	**1.0** Clean the bilge, place white paper on the floor of the bilge and run the engine to locate oil leaks.
	1.1 Oil too thin	**1.1** Change the oil.
	1.2 Oil level too high	**1.2** Drain the oil and verify the cause of the excessive oil. Change the oil and recheck periodically.
	1.3 Drain holes in cylinder head plugged causing oil to flood the valves	**1.3** Clean the drain holes.
	1.4 Defective valve seals	**1.4** Replace the valve seals.
	1.5 Intake manifold gasket leaking	**1.5** Replace the intake manifold gasket.
	1.6 Worn valve stems or valve guides	**1.6** Replace the valves or valve guides.
	1.7 Defective oil cooler	**1.7** Replace the oil cooler.
	1.8 Defective piston rings	**1.8** Replace the piston rings.
	1.9 Excessive bearing clearance	**1.9** Replace the bearings.

NOTE: *ENGINE CRANKCASE OIL MUST BE CHECKED AT INTERVALS SPECIFIED IN MAINTENANCE SCHEDULES. It is normal for an engine to use a certain amount of oil in the process of lubricating and cooling the engine. The amount of oil consumption is greatly dependent upon engine speed, with consumption being highest at wide open throttle and decreasing substantially as the engine speed is reduced.*

Water In The Engine

Important Information

IMPORTANT: First determine the location of the water in the engine. This information can be of great help when trying to determine where the water came from and how it got into the engine. The 3 most common problems are: water on top of the pistons, water in the crankcase oil, and when both of those conditions occur simultaneously.

1. After locating the water, remove all the water from the engine by removing all the spark plugs and cranking the engine over to pump out the cylinders.
2. Change the oil and the filter.
3. Start the engine and see if the problem can be duplicated. If the problem can be duplicated, a mechanical problem exists. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If the water is contained to the cylinders only, it is usually entering through the intake system, the exhaust system, or the cylinder head gasket.

If the water is contained to the crankcase only, it is usually caused by a cracked or porous engine block, a flooded bilge, or condensation.

If the water is located in both the cylinders and the crankcase, it is usually caused by water in the cylinders getting past the piston rings and valves or complete submersion.

Checking for rust in the intake manifold or the exhaust manifolds is a good idea. Rust is a clue that the water entered these areas.

Water In Engine (continued)

Symptom	Cause	Action
1. Water on top of the pistons	**1.0** The operator shut the engine off at a high rpm	**1.0** Read Boat in the Water Procedure in the Operation, Maintenance and Warranty Manual.
	1.1 Engine diesels or tries to run backwards	**1.1** Adjust the throttle cable. Ensure engine idles properly.
	1.2 Rain water dripping into the flame arrestor	**1.2** Replace the engine cover.
	1.3 Spark plug misfiring	**1.3** Inspect and service the spark plugs. Replace if necessary.
	1.4 Water ingestion through the exhaust system	**1.4** Repair the exhaust system.
	1.5 Improper engine or exhaust hose installation	**1.5** Check the engine installation specifications.
	1.6 Cracked exhaust manifold	**1.6** Replace the exhaust manifold.
	1.7 Improper manifold to elbow gasket installation	**1.7** Replace the manifold to elbow gasket.
	1.8 Loose cylinder head bolts	**1.8** Tighten the cylinder head bolts.
	1.9 Blown cylinder head gasket	**1.9** Determine the cause of blown gasket and replace the gasket.
	1.10 Cracked valve seat	**1.10** Replace the valves.
	1.11 Cracked or porus castings	**1.11** Inspect and repair or replace as necessary.
2. Water in crankcase oil	**2.0** Water in boat bilge	**2.0** Drain the water from the bilge.
	2.1 Water seeping past the piston rings or valves	**2.1** Replace the piston rings or the valves.
	2.2 Engine operating cold	**2.2** Replace the thermostat.
	2.3 Intake manifold leaking near a water passage	**2.3** Inspect the intake manifold for cracks. Check the gaskets.
	2.4 Cracked or porous casting	**2.4** Check the cylinder head, the cylinder block and the intake manifold for cracks or porosity.

Engine Overheats (Mechanical)

IMPORTANT: The first step is to verify if the engine is actually overheating or if the temperature gauge or sender is faulty.

Symptom	Cause	Action
1. Engine overheats (mechanical)	**1.0** Engine rpm below specifications at WOT (engine laboring)	**1.0** Replace the propeller. Clean the boat bottom. Check the false bottom for water.
	1.1 Incorrect rotor location	**1.1** Reset rotor location.
	1.2 Spark plug wires crossed (wrong firing order)	**1.2** Install the spark plug wires correctly.
	1.3 Lean fuel mixture	**1.3** Drain the fuel tank and refill with the appropriate fuel.
	1.4 Wrong heat range spark plugs	**1.4** Replace the spark plugs.
	1.5 Exhaust restriction	**1.5** Inspect the exhaust system and repair.
	1.6 Valve timing incorrect	**1.6** Adjust the valves.
	1.7 Blown cylinder head gaskets	**1.7** If the engine overheats above 3000 rpm, replace the cylinder head gasket. On seawater cooled engines, install a clear plastic hose between the thermostat housing and the exhaust manifolds. If air bubbles are present at a higher rpm, replace the cylinder head gasket.
	1.8 Insufficient lubrication to the moving parts of the engine	**1.8** Check the oil level. add if necessary. Check the oil flow through the oil passages. Clean as necessary.

Engine Overheats (continued)

Symptom	Cause	Action
2. Engine overheats (cooling system)	**2.0** Loose or broken drive belt	**2.0** Replace the serpentine drive belt.
	2.1 Seawater shut off valve partially or fully closed (if equipped)	**2.1** Open the seawater shut off valve.
	2.2 Clogged or improperly installed seawater strainer	**2.2** Clean the seawater strainer. Reinstall the seawater strainer.
	2.3 Loose hose connections between the seawater pickup and seawater pump inlet	**2.3** Tighten all hose clamps.
	2.4 Seawater inlet hose kinked or collapsed	**2.4** Visually inspect the seawater inlet hose and shorten or replace as necessary.
	2.5 Seawater pickup clogged	**2.5** Clean the seawater pickup.
	2.6 Marine growth on boat bottom	**2.6** Clean the boat bottom.
	2.7 Defective thermostat	**2.7** Replace the thermostat.
	2.8 Exhaust elbow water outlet holes plugged	**2.8** Clean the water outlet holes.
	2.9 Insufficient seawater pump operation	**2.9** Refer to **section 6.**
	2.10 Obstruction in cooling system such as casting flash, sand, rust, and salt.	**2.10** Flush the cooling system.
	2.11 Engine water circulating pump defective	**2.11** Replace the water circulating pump.
	2.12 Low coolant level	**2.12** Fill the coolant reservoir.
	2.13 Antifreeze not mixed properly	**2.13** Drain and replace the coolant.
	2.14 Heat exchanger cores plugged	**2.14** Clean the heat exchanger.
	2.15 Water hoses reversed at the water distribution block	**2.15** Install the hoses properly.
	2.16 Worn or damaged seawater pump impeller	**2.16** Replace the seawater pump impeller.
	2.17 For engines using thermostst housing with T-fitting. Loose or damaged check ball sealing springs	**2.17** Replace the check ball sealing springs.
	2.18 Damaged or warped check balls	**2.18** Replace check balls
	2.19 Air vents in thermostat housing located in the port for the thermostat housing T-fitting blocked	**2.19** Remove the thermostat housing T-fitting and check the air vents for blockage. clear blockage if necessary.

Engine Overheats (continued)

3. Insufficient water flow from the belt driven seawater pickup pump	**3.0** Loose or broken drive belt	**3.0** Replace the serpentine drive belt.
	3.1 Seawater shut off valve partially or fully closed (if equipped)	**3.1** Open the seawater shut off valve.
	3.2 Clogged or improperly installed seawater strainer	**3.2** Clean the seawater strainer. Reinstall the seawater strainer.
	3.3 Loose hose connections between the seawater pickup and seawater pump inlet	**3.3** Tighten all hose clamps.
	3.4 Seawater inlet hose kinked or collapsed	**3.4** Visually inspect the seawater inlet hose and shorten or replace as necessary.
	3.5 Seawater pickup clogged	**3.5** Clean the seawater pickup.
	3.6 Marine growth on boat bottom	**3.6** Clean the boat bottom.
	3.7 Faulty seawater pump	**3.7** Replace the seawater pump.
	3.8 Worn or damaged seawater pump impeller	**3.8** Replace the seawater pump impeller.

Power Steering

Symptom	Cause	Action
1. Poor, erratic, or no assist	**1.0** Loose or broken drive belt	**1.0** Replace the drive belt.
	1.1 Fluid level low	**1.1** Fill the system.
	1.2 Air in the system	**1.2** Bleed the lines.
	1.3 Leaking hoses	**1.3** Bleed the lines.
	1.4 Steering cables and/or steering helm binding	**1.4** Clean the rust or the debris from the cable and the helm. Remove and reinstall the cable. Check the cable lubrication.
	1.5 Restriction in hydraulic hoses causing loss of pressure	**1.5** Inspect the hydraulic hoses for kinks.

Power Steering (continued)

Symptom	Cause	Action
1. Poor, erratic or no assist (continued)	**1.7** Control valve not properly positioned.	**1.7** Position control valve properly.
	1.8 Mounting bracket adjusting screw loose.	**1.8** Tighten the mounting nut.
	1.9 Faulty pump causing flow control valve to stick.	**1.9** Repair or replace the pump.
	1.10 Leaking valve body or loose fitting spool	**1.10** Tighten the fitting spool. Repair or replace the valve body.
2. Noisy pump	**2.0** Drive belt loose	**2.0** Replace the serpentine drive belt.
	2.1 Low fluid level	**2.1** Fill the power steering pump reservoir and bleed the lines.
	2.2 Air in fluid	**2.2** Drain the power steering system. Fill the power steering pump reservoir.
	2.3 Faulty pump	**2.3** Replace the pump.
	2.4 Steering cables installed that do not meet BIA standards	**2.4** Install the appropriate cables.
3. Fluid leaks	**3.0** Loose hose connections	**3.0** Tighten all hose clamps. Bleed the system.
	3.1 Damaged hose	**3.1** Inspect and replace the damaged hose.
	3.2 Oil leaking from the top of the pump	**3.2** Drain excess oil.
	3.3 Cylinder piston rod seal leaks	**3.3** Install new seal kit.
	3.4 Faulty seals or O-rings in the pump	**3.4** Replace the seals or the O-rings in the pump.
	3.5 Cracked or porous metal parts	**3.5** Inspect all power steering components for leaks.

Transmission

NOTE: *Refer to the transmission manufacturer's information for detailed troubleshooting. This information is meant as a guide only.*

Symptom	Cause	Action
1. Transmission will not shift	**1.0** Shifting lever is loose and cannot be shifted	**1.0** Tighten clamping bolt on the shifting lever.
2. Delayed shift time	**2.0** Shift linkage misadjusted; not allowing full engagement	**2.0** Lift remote control off. If gear can be shifted by hand, correct remote control. If the transmission cannot be shifted correctly by hand, refer to the transmission service manual.
3. Clutch is slipping; propeller speed too low as compared to engine speed	**3.0** Inadmissible fluid used	**3.0** Drain fluid. Refill with prescribed fluid. Flush transmission while engine runs in NEUTRAL position. Drain fluid. Refill transmission.
4. Transmission locked		**4.0** Replace the transmission.
5. Excessive fluid temperature	**5.0** Excessive fluid in transmission **5.1** Fluid cooler is dirty on water side	**5.0** Remove excessive fluid. **5.1** Detach coolant water lines and clean fluid cooler on water side.
6. Water in the fluid, fluid looks milky	**6.0** Fluid cooler faulty **6.1** High water level in engine compartment, water entering through output shaft seal or breather	**6.0** Repair leakage at cooler or replace cooler. Change transmission fluid. **6.1** Remedy cause for water level in engine compartment. Change transmission fluid.
7. Fluid leakage at breather	**7.0** Excessive fluid in transmission	**7.0** Pump excessive fluid out with commercial hand pump.
8. Transmission noise becomes louder	**8.0** Fluid level too low so that pump sucks in air **8.1** Damage starting on flexible coupling due to wear or fatigue, possibly due to misalignment between engine and transmission	**8.0** Fill to mark on dipstick with appropriate fluid. **8.1** Replace flexible coupling. Check alignment between engine and transmission.
9. Chattering transmission noise mainly at low engine speed	**9.0** Misaligned propeller shaft on output	**9.0** Mount and align propeller shaft strictly according to instructions issued by shaft manufacturerr.

Drain System Will Not Drain Or Drains Slowly

Symptom	Cause	Action
1. Drain system will not drain or drains slowly	**1.0** Drain system not open	**1.0** Verify draining procedure.
	1.1 Cooling system or drain holes plugged with debris	**1.1** Inspect drain hole in the water distribution housing for debris. Remove the blue drain plugs and inspect for blockage. Flush the cooling system and drain the engine.
	1.2 Air actuator malfunction	**1.2** Inspect the air lines from the air manifold and the drain actuator for kinks, damage and leaks. Inspect the air manifold and the fittings for cracks, leaks, damage, or corrosion.
	1.3 Boat sitting on an incline	**1.3** Boat must be at rest and level when draining the engine.
	1.4 Draining the engine while boat is in the water	**1.4** Read Boat in the Water Procedure in the Operation, Maintenance and Warranty Manual.
	1.5 Water in the engine is frozen	**1.5** Thaw engine and inspect for freeze damage.

Drain System Will Not Drain Or Drains Slowly (continued)

Symptom	Cause	Action
2. Drain system leaking at the orange drain seal	**2.0** Drain rod misaligned	**2.0** Realign the drain rod.
	2.1 Drain rod bent	**2.1** Replace the drain rod.
	2.2 Drain rod not closed completely (red visible)	**2.2** Close drain system.
	2.3 Actuator piston not closed	**2.3** Activate pressure relief valve.
		Inspect and clean the water distribution housing and the seawater pump drain actuator. Replace if damaged.
3. Manual drain system leaking while underway	**3.0** Drain rod misaligned	**3.0** Realign the drain rod.
	3.1 Drain rod bent	**3.1** Replace the drain rod.
	3.1 Drain rod scratched, cut, or damaged	**3.1** Replace the drain rod.
	3.2 Water distribution housing seal damaged	**3.2** Replace the housing.
4. Water leaking out of the pressure relief valve on the air manifold	**4.0** Seawater pump seal leaking	**4.0** Replace the drain portion of the seawater pump.
	4.1 Vents on the drain actuator are under the waterline	**4.1** Empty water from bilge.

IMPORTANT INFORMATION

Section 1D - California Emissions Information

1 D

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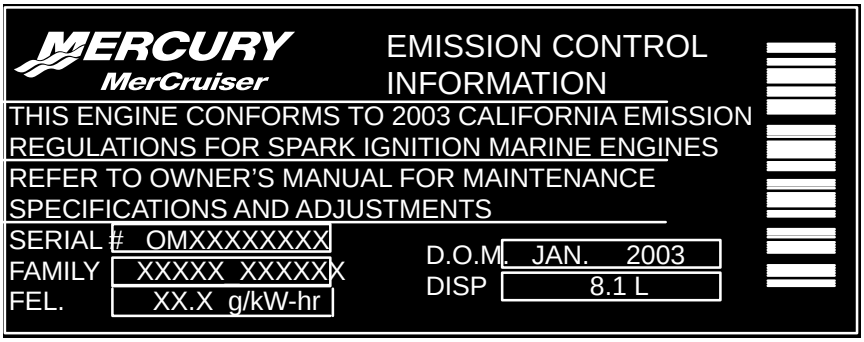
Emissions Information

Emission Control Information Label

NOTE: *If part with emission control information is removed it will be necessary to order a new decal and install it on the new part.*

A tamper-resistant Emission Control Information label is affixed in a visible location to the engine at time of manufacture by Mercury MerCruiser. In addition to the required emissions statement, the label lists the engine serial number, family, FEL (emission level), date of manufacture (month, year), and the engine displacement. Please note that the low emissions certification will not affect the fit, function, or performance of the engines. Boatbuilders and Dealers may not remove the label or the part it is affixed to before sale. If modifications are necessary, contact Mercury MerCruiser about the availability of replacement decals before proceeding.



79005

"SERIAL#" - Engine Serial Number

"FAMILY" - Engine Family

"FEL." - Family Emission Limit

"D.O.M." - Date of Manufacture

"DISP" - Piston Displacement

Components Of The Emissions Control System

1. Fuel Metering System
   a. Carburetor and internal parts (and/or pressure regulator or fuel injection system)
   b. Intake valve(s)
2. Air Induction System
   a. Intake manifold
3. Ignition System
   a. Spark plugs
   b. Electronic ignition system
   c. Ignition coil and/or control module
   d. Ignition wires
4. Positive Crankcase Ventilation (PCV) System
   a. PCV Valve
   b. Oil filler cap
5. Exhaust System
   a. Exhaust manifold
   b. Exhaust elbow
   c. Intermediate exhaust elbow
   d. Lower exhaust pipe
   e. Tailpipe
   f. Exhaust valve
6. Miscellaneous Items Used in Above Systems
   a. Hoses, clamps, fittings, tubing, sealing gaskets or devices, and mounting hardware.
   b. Pulleys, belts, and idlers.
   c. Vacuum, temperature, check and time sensitive valves and switches
   d. Electronic controls.

Disclaimers And Limitations

DISCLAIMERS AND LIMITATIONS

THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY DISCLAIMED. TO THE EXTENT THAT THEY CANNOT BE DISCLAIMED, THE IMPLIED WARRANTIES ARE LIMITED IN DURATION TO THE LIFE OF THE EXPRESS WARRANTY. INCIDENTAL AND CONSEQUENTIAL DAMAGES ARE EXCLUDED FROM COVERAGE UNDER THIS WARRANTY. SOME STATES/COUNTRIES DO NOT ALLOW FOR THE DISCLAIMERS, LIMITATIONS AND EXCLUSIONS IDENTIFIED ABOVE. AS A RESULT, THEY MAY NOT APPLY TO YOU. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER LEGAL RIGHTS WHICH VARY FROM STATE TO STATE AND COUNTRY TO COUNTRY.

If you have any questions regarding your warranty rights and responsibilities, refer to Owner Service Assistance for contact information.

Star Label

Beginning January 1, 2003, one 3-Star label will be included with each factory-certified Mercury MerCruiser engine.

All Mercury MerCruiser engines (500 hp and below) will have a 3-Star Ultra Low Emission rating. The 3-Star label identifies that these engines meet the California Air Resources Board's Sterndrive and Inboard marine engine 2003 exhaust emission standards. Engines meeting these standards have 65% lower emissions than One Star - Low Emission engines.

1. Refer to the instructions included in the parts bag and affix the supplied Star label to the front port side of the boat in which the California factory-certified engine is installed.

Hang Tag

The Dealer must mark the appropriate box on one hang tag to match the Star label affixed to the boat. The dealer is responsible for displaying the hang tag in a visible location on the boat on display in California. Failure to properly display the hang tag could result in a citation and possible fine to the dealer from the California Air Resources Board.

1. If in California, the dealer must place the hang tag in a visible location in the boat prior to displaying the boat.

Emission Control Information Label Request Form

To obtain a decal request form, contact your customer service representative at 405-743-6555.

REMOVAL AND INSTALLATION

Section 2A - MCM Models

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Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Engine Coupler Spline Grease	Coupler splines	92-802869A1
	Drive unit pilot	
	U-joint O-rings	
	Drive shaft splines	
2-4-C With Teflon	Anchor pins	92-802859A1
	Trim cylinder hardware	
	O-ring seals	
	Shift cable end	
	Propeller splines	
Special Lubricant 101	Pivot bolts	92-802865A1
	Power steering bushings	
	Clevis pin	
	Steering cable end	
	Propeller splines	
Dexron III - Automatic Transmission Fluid	Power steering pump	Obtain Locally
Power Trim and Steering Fluid	Power steering pump	92-802880A1
	Power trim pump	
Liquid Neoprene	Battery terminals	92-25711-3
	MerCathode connections	
Loctite 565 PST	Speedometer barb fitting	Obtain Locally
	Fuel inlet fitting	
	Seawater inlet hose fitting threads	
	Seawater inlet plastic plug threads	
	Fuel line connector male pipe threads	

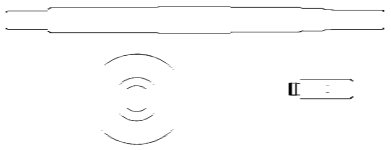
Equivalent products may be used.

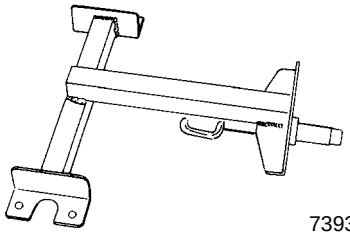
Lubricants / Sealants / Adhesives (continued)

Description	Where Used	Part Number
Loctite 271 Threadlocker	Seawater inlet nut	92-809819
	Trim cylinder bolt threads	
SAE 30W Engine Oil	Shift cable pivot points	Obtain locally
SAE 10W40 Engine Oil	Power trim pump	Obtain locally
Marine Caulking	Seawater inlet mounting surfaces	Obtain locally
Liquid Soap	Exhaust tubes	Obtain locally
High Performance Gear Lube	Sterndrive unit	92-802854A1
	Gear lube monitor	
Silicone Sealant	Seawater pickup screw shaft	Obtain locally
Battery Terminal Sealant	Battery terminals	Obtain locally

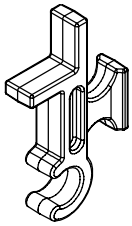
Equivalent products may be used.

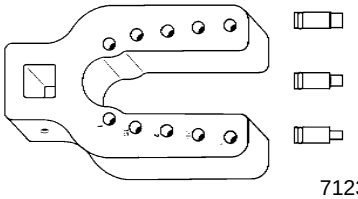
Special Tools

Alignment Tool Assembly		
 73699	Aligns the engine and the sterndrive unit during installation.	91-805475A1

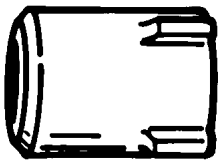
Installation Jig		
 73934	Use to place the engine mounts when installing Mercury MerCruiser V8 or V6 engines.	91-806794A1

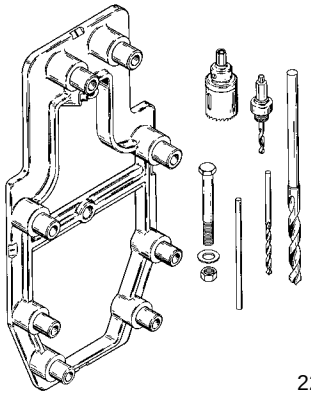
Shift Cable Adjustment Tool		
73479	Attaches over the shift cable. Use for proper Bravo sterndrive unit shift cable adjustment at the shift plate.	91-12427

Shift Shaft Slide Stabilizer		
 79288	Use to hold the Alpha shift shaft slide in the proper position as the sterndrive unit is installed onto the bell housing studs.	91-865232

Spanner Wrench		
 71233	Removes trim cylinder end cap on all Mercury MerCruiser trim cylinders. Uses interchangeable pin sets: 91-811907 Large pin set: 0.235 in. (5.97 mm) 91-811908 Medium pin set: 0.180 in. (4.57 mm) 91-811909 Small pin set: 0.150 in. (3.81 mm)	91-821709T

Special Tools (continued)

Tapered Insert Tool		
 73456	Installs the tapered insert retainer into the water inlet hose on all the Bravo and Blackhawk sterndrive units.	91-43579

Transom Cutout and Drill Fixture		
 22056	Use when cutting and drilling the boat transom for sterndrive installation.	91-43693A2

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb-in.	lb-ft
Speedometer pickup barb fitting	1.5	13	
Exhaust pipe plate	34		25
Exhaust block-off plate screw	34		25
Power steering hydraulic hose fittings	34		25
Power trim pump hose fittings	14	125	
Single propeller nut[1]	75		55
	Then align tabs with grooves.		
Front dual propeller nut	136		100
Rear dual propeller nut	81		60
Rear engine mounts	47		35
Steering cable coupler nut	47		35
Pivot bolts	34		25
Sterndrive unit fasteners	68		50
Transom assembly fasteners	34		25
Water inlet block-off screws	5	45	
Fuel inlet fitting	Hand-tight + 1-3/4 to 2-1/4 turns with a wrench. Do not overtighten.		
Trim cylinder bolt	23.5		17.5
Trim cylinder end cap	61		45
Seawater inlet nut	47		35
Exhaust tube clamps	4	35	
Hose clamps	3.4-6.8	30-60	
Mounting clip screw	12	108	
Fuel line connectors	19-27		14-20
Battery stud	8-11	71-97	
Flame arrestor bolts	12	108	

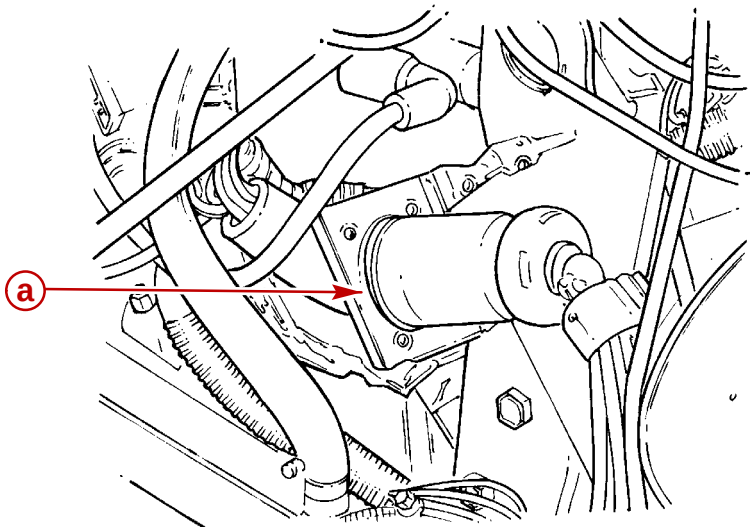
[1] *Amount specified is MINIMUM.*

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire, or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect the battery cables from the battery.
2. Remove the engine cover.
3. Loosen the clamp and remove the instrument wiring harness plug from the engine wiring harness receptacle.



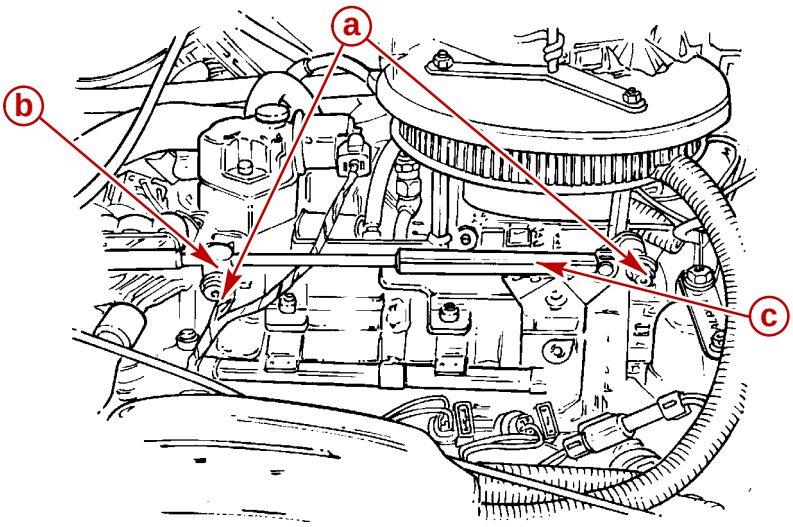
78031

a - Engine wiring harness receptacle

⚠ WARNING

Be careful when working on the fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

4. Loosen the hose clamp retaining fuel line to the fuel inlet.
5. Close the fuel shut off valve, if equipped.
6. Disconnect and plug the fuel line to prevent fuel in the line from leaking into the bilge.
7. Disconnect the throttle cable and retain the fasteners.



78033

a - Flat washer and locknut
b - Cable barrel
c - End guide

8. Disconnect the shift cable from the shift plate and retain the fasteners.
9. Disconnect the power steering hoses.
10. Disconnect the seawater inlet hose from the transom.
11. Loosen the hose clamps at the bullhorn.
12. Remove the gear lube monitor and the hose and place out of the way.
13. Disconnect any grounding wires and accessories that are connected to the engine.

⚠ CAUTION

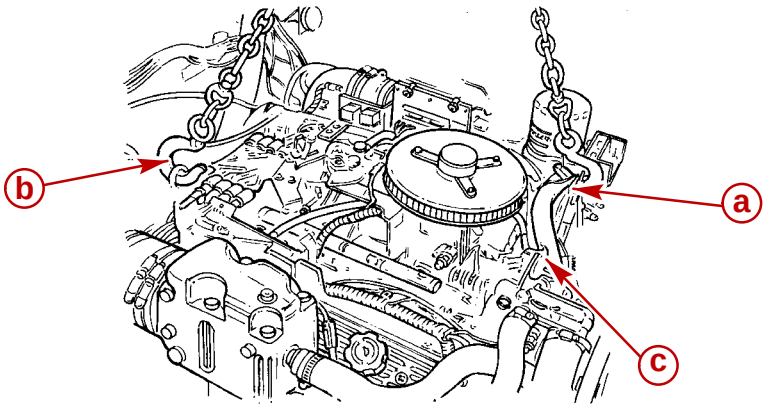
Engine MUST be lifted with a lifting arm or damage to the engine components will occur. Do not allow the lifting sling to hook or compress the engine components or damage will occur.

IMPORTANT: Engine compartment size may require the removal of additional components.

14. Support the engine with a suitable sling through the lifting eyes on the engine.

⚠ CAUTION

Center lifting eye on top of thermostat housing is used for engine alignment only. Do not use to lift entire engine.

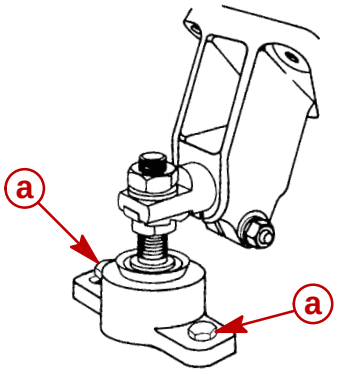


77912

a - Front lifting eye
b - Rear lifting eye
c - Center lifting eye

15. Remove the rear engine mounting bolts.

16. Remove the front lag bolts. Retain the fasteners.



72638

a - Lag bolt (with washers)

17. Carefully remove the engine.

Engine Installation

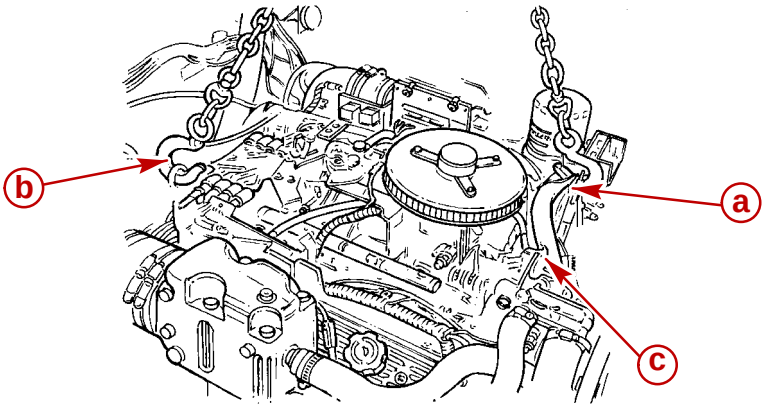
NOTE: *An engine mount drilling fixture (91-806794A1) can be used to align and adjust the engine mounts. Refer to instructions with the fixture for proper use.*

1. Attach a suitable sling to the lifting eyes on the engine and adjust so that the engine is level when suspended.

⚠ CAUTION

Center lifting eye on top of the thermostat housing is used for engine alignment only. Do not use to lift the entire engine.

2. Lift the engine into position in the boat using an overhead hoist.



77912

a - Front lifting eye
b - Rear lifting eye
c - Center lifting eye

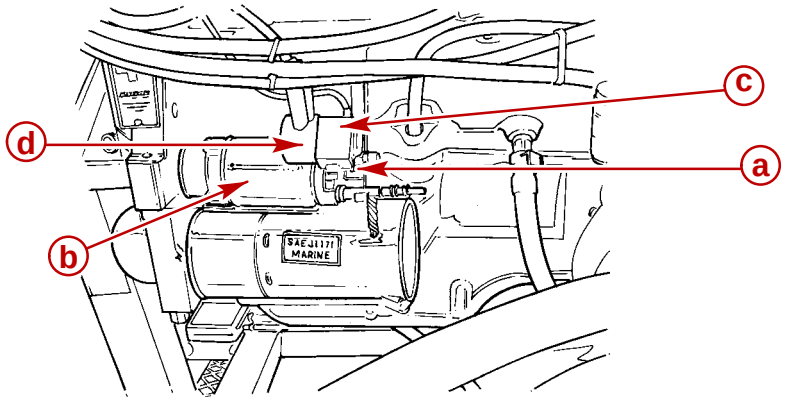
3. Ensure that the grounding stud and starter solenoid terminal are free of paint or any other material that could cause a poor electrical connection.
4. Connect the battery cables to the engine. Apply a thin coat of sealant to the terminals.

Description	Where Used	Part Number
Liquid Neoprene	Battery Terminals	92-25711-3

5. Slide the rubber boot over the positive (+) terminal.

6. Drape battery cables over top of engine to prevent interference during installation.

IMPORTANT: There is a fuse located at the starter solenoid. Do not remove this fuse. The positive battery cable must be connected to the same stud as the fuse.

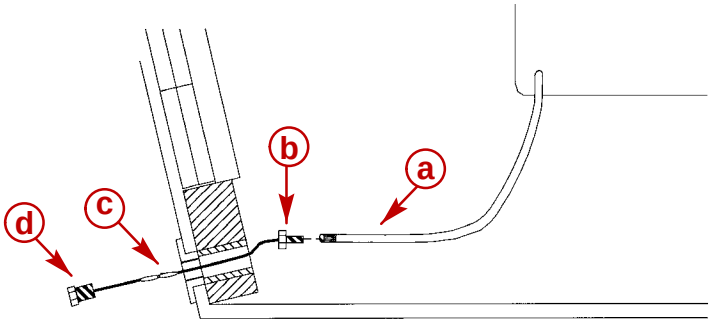


77907

PG260F1 shown, others similar

- **a** - Positive (+) battery cable (not shown)
- **b** - Starter solenoid
- **c** - 90 amp fuse - Do Not Remove
- **d** - Rubber boot location

7. Push the end of the oil drain hose out of the boat hull through the flange.
8. Pull the oil drain hose out until it is 152 mm (6 in.) from the propeller.
9. Move the alignment clip on the oil drain hose and squeeze to position it on the hose just inside the boat hull against the flange.
10. Connect the bilge drain plug to the oil drain hose plug using the clip.

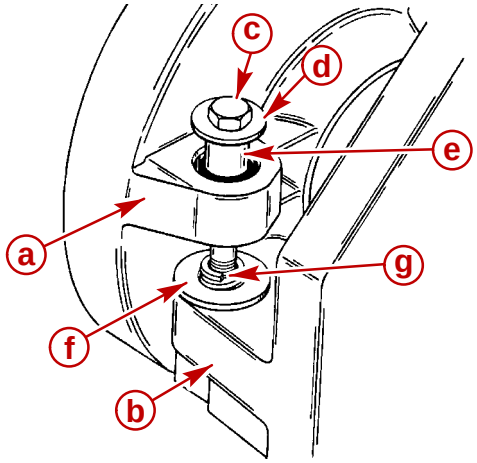


78002

- **a** - Oil drain hose
- **b** - Alignment clip
- **c** - Clip
- **d** - Bilge drain plug

IMPORTANT: If the quick drain oil fitting is within 13 mm (1/2 in.) of the boat bottom, remove the fitting and install the drain plug from the parts bag directly into the oil pan.

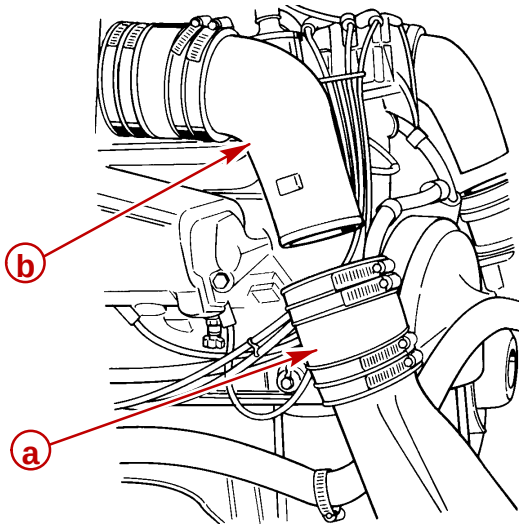
11. Push the oil drain hose through the flange into the boat hull.
12. Install the bilge drain plug in the hull.
13. Align the rear engine mounts with the inner transom plate mounts while simultaneously aligning the exhaust tube with the exhaust pipe bellows.



22032

a - Rear engine mount
b - Inner transom plate mount
c - Bolt
d - Washer
e - Spacer
f - Fiber washer (serial number 0M599999 and below)
g - Double-wound lockwasher (serial number 0M599999 and below)

14. Install both the rear engine mounting bolts and the hardware. Torque the bolts and the hardware. Do not relieve the tension on the hoist.



50682

a - Exhaust pipe bellows
b - Exhaust tube

Description	Nm	lb-in.	lb-ft
Rear engine mounts	47		35

IMPORTANT: If the quick drain oil fitting is within 13 mm (1/2 in.) of the boat bottom, remove the fitting and install the drain plug from the parts bag directly into the oil pan.

15. Ensure that the quick drain oil fitting is more than 13 mm (1/2 in.) above the boat bottom.

⚠ CAUTION

Do not use an alignment tool from a manufacturer other than Quicksilver as it may cause improper alignment and damage to the gimbal bearing or the engine coupler.

⚠ CAUTION

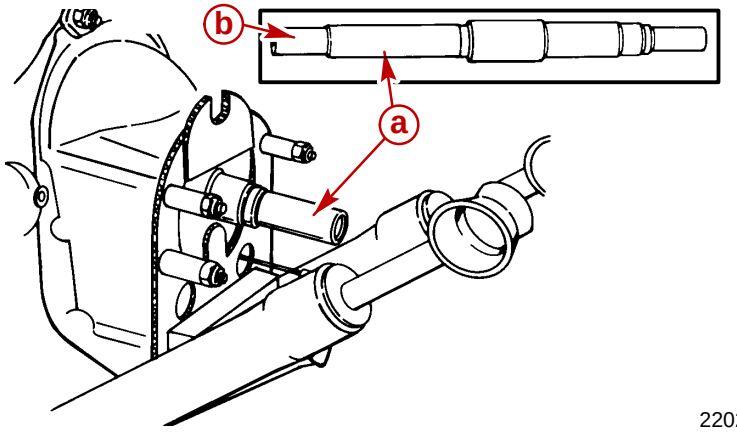
To avoid damage to the gimbal bearing, the engine coupler, or the alignment tool:

- **Do not attempt to force the alignment tool!**
- **Do not raise or lower the engine with the alignment tool inserted (or partially inserted) in the gimbal bearing or the engine coupler.**

16. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines.

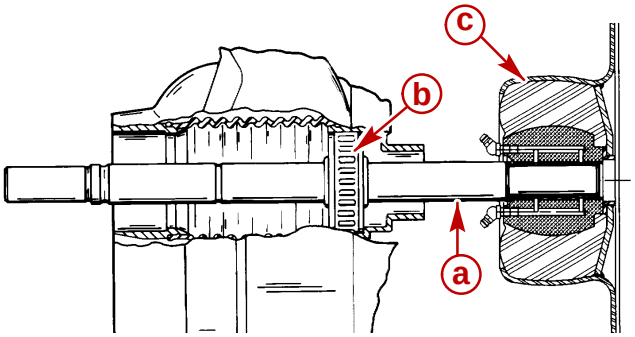
17. If the tool does not fit, remove it and carefully raise or lower the front end of the engine using the center alignment eye and attempt to insert the alignment tool.

18. Repeat Step 17. until the alignment tool installs easily **(SLIDES FREELY WITH 2 FINGERS)** all the way into and out of the engine coupler splines. Do not check by turning.



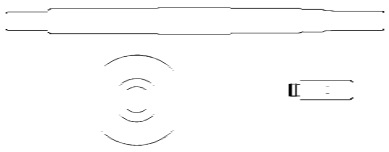
22029

a - Alignment tool (use only recommended alignment tool)
b - Insert this end of alignment tool through gimbal housing assembly



27647

a - Alignment tool
b - Gimbal bearing
c - Engine coupler

Alignment Tool Assembly		
 73699	Aligns the engine and the sterndrive unit during installation.	91-805475A1

IMPORTANT: Finished boat stringer must position the engine so that a minimum mount adjustment exists after the front mount is adjusted down to the stringer. This allows for future adjustments.

IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in the direction required to align the engine.

19. Adjust the front engine mounts until they rest on the boat stringers.

20. Relieve the hoist tension entirely and fasten both front mounts to the boat stringer using appropriate hardware.

21. Recheck the alignment with the alignment tool. The tool must enter the engine coupler splines freely. If not, readjust the front mounts.
22. When the alignment is correct, tighten the locknut securely. Recheck the alignment.
23. Bend the tab down on the adjusting nut.
24. Remove the alignment tool.
25. Install the sterndrive unit.

Electrical Connections

MPI Electrical System Precautions

⚠ CAUTION

Avoid damage to the MPI electrical system components. Refer to the following precautions when working on or around the MPI electrical harness or when adding other electrical accessories:

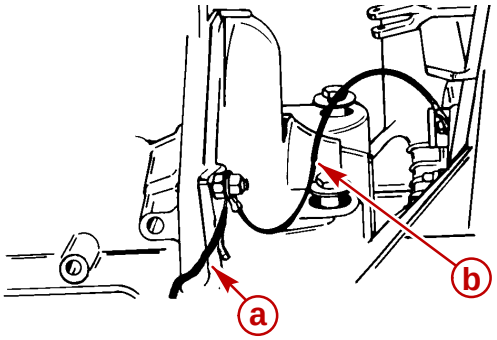
- **Do not tap the accessories into the engine harness.**
- **Do not puncture wires for testing (Probing).**
- **Do not reverse the battery leads.**
- **Do not splice wires into the harness.**
- **Do not attempt diagnostics without proper, approved Service Tools.**

IMPORTANT: When routing all wire harnesses and hoses, ensure that they are routed and secured to avoid coming in contact with hot spots on the engine and to avoid contact with moving parts.

Installing Continuity Wire

1. Connect the continuity circuit wire from the engine to the transom assembly.

IMPORTANT: Do not attach any accessory ground (–) wires to the transom plate ground point. Accessory ground wires can only be attached to the ground stud on the engine.



71651

a - Negative (–) battery cable
b - Continuity circuit wire

Instrumentation Connections

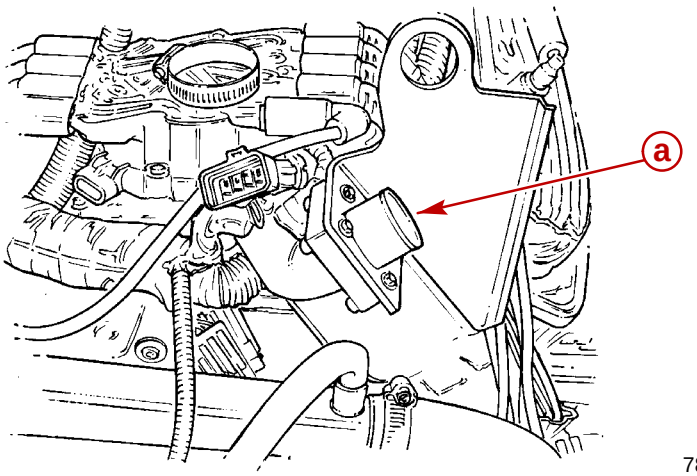
We recommend the use of Quicksilver Instrumentation and Wiring Harnesses which have been specifically designed for compatibility with our engines. Instrumentation wiring extension harnesses are available in several lengths. Refer to ***Mercury Precision Parts / Quicksilver Accessories Guide*** for selection.

Refer to Instrumentation Wiring Diagrams for specific wiring diagrams.

⚠ CAUTION

If a Quicksilver wiring harness is used and a fused accessory panel is to be installed (40-amp current draw maximum), connect it as shown in the wiring diagrams. Do not connect the accessory panel at any other location as the wires in the wiring harness may not be of sufficient size to handle the current load.

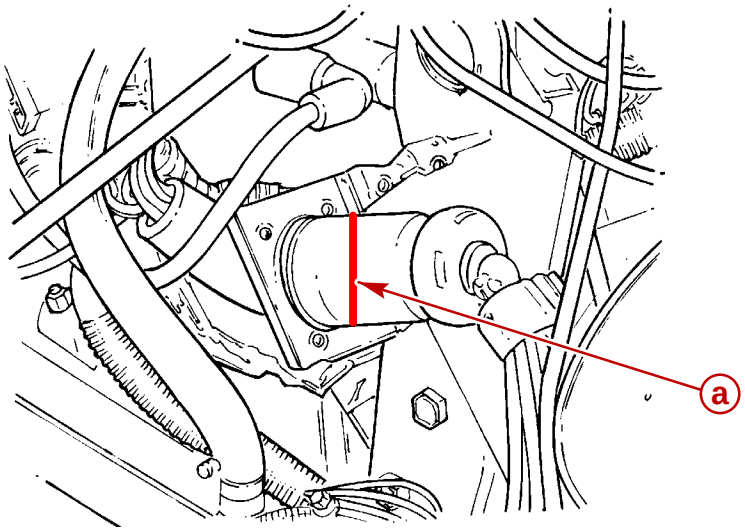
1. Connect the instrumentation wiring harness to the engine harness plug.



78030

a - Engine wiring harness receptacle

2. Secure the harness with the hose clamp.

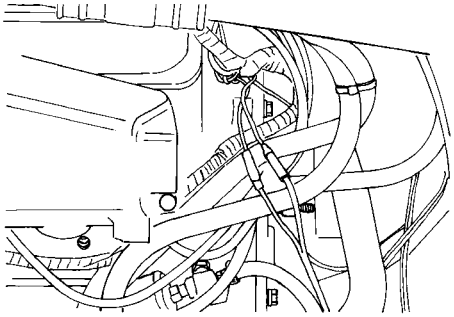


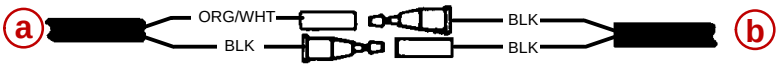
78031

a - Hose clamp location

Trim Position Sender Connections

1. Connect the trim position sender wires from the transom assembly to the engine harness. Use the ORG/GRY wire for analog gauges and the ORG/WHT for digital gauges.





74029

Digital gauge connection shown, analog similar

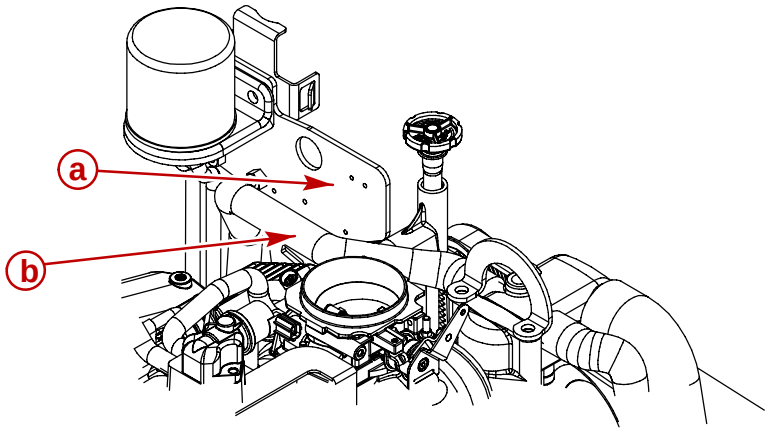
a - Engine harness bullet connector
b - Transom assembly bullet connectors

MerCathode Connections

STANDARD MERCATHODE

The MerCathode controller assembly is located on the back of the front lifting eye. The upper hose must be disconnected from the thermostat housing for access.

1. Remove the thermostat housing hose to gain access to the MerCathode controller assembly.

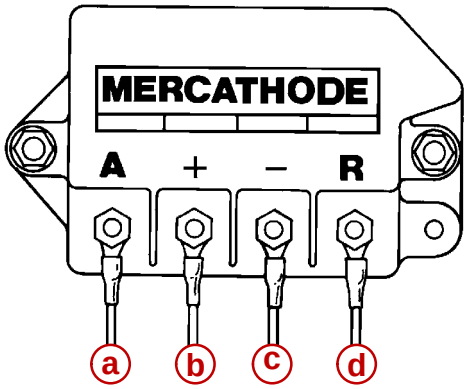


78129

a - MerCathode controller location
b - Thermostat housing hose

2. Connect the wires to the MerCathode controller assembly. Apply a thin coat of sealant to all wire connections.

IMPORTANT: The opposite end of the RED/PURPLE wire must be connected directly to the battery positive (+) terminal. Do not connect it to a switched positive (+) circuit. The MerCathode system must function continuously for proper corrosion protection.

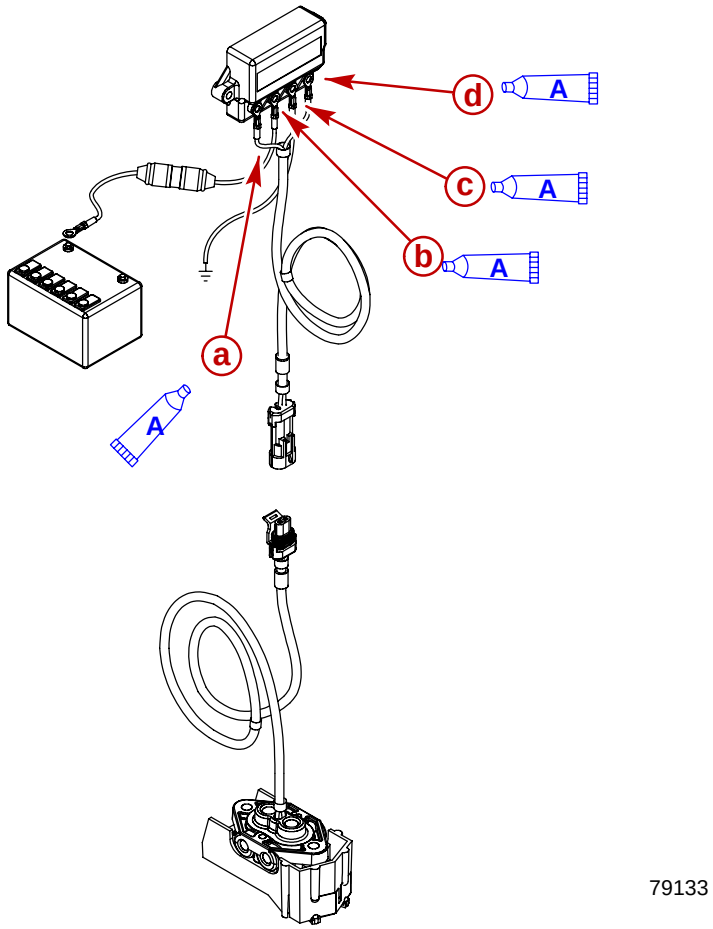


22232

a - ORANGE wire - from electrode on transom assembly
b - RED/PURPLE wire - connect (other end) to positive (+) battery terminal
c - BLACK wire - from engine harness
d - BROWN wire - from electrode on transom assembly

QUICK CONNECT MERCATHODE

1. Connect the male and female quick connects.



a - ORANGE lead - from anode on transom assembly (part of quick connect)
b - RED/PURPLE wire - to positive (+) battery terminal
c - BLACK wire - from engine harness
d - BROWN wire - from electrode on transom assembly (part of quick connect)

Description		Where Used	Part Number
A	Liquid Neoprene	MerCathode connections	92-25711-3

Audio Warning Alarm Connections

1. Connect the PURPLE wire from the alarm to any PURPLE wire terminal on the instrument gauge or the ignition switch. Tighten the connection securely.
2. Connect the TAN/BLUE wire from the alarm to the TAN/ BLUE wire from the instrument harness.

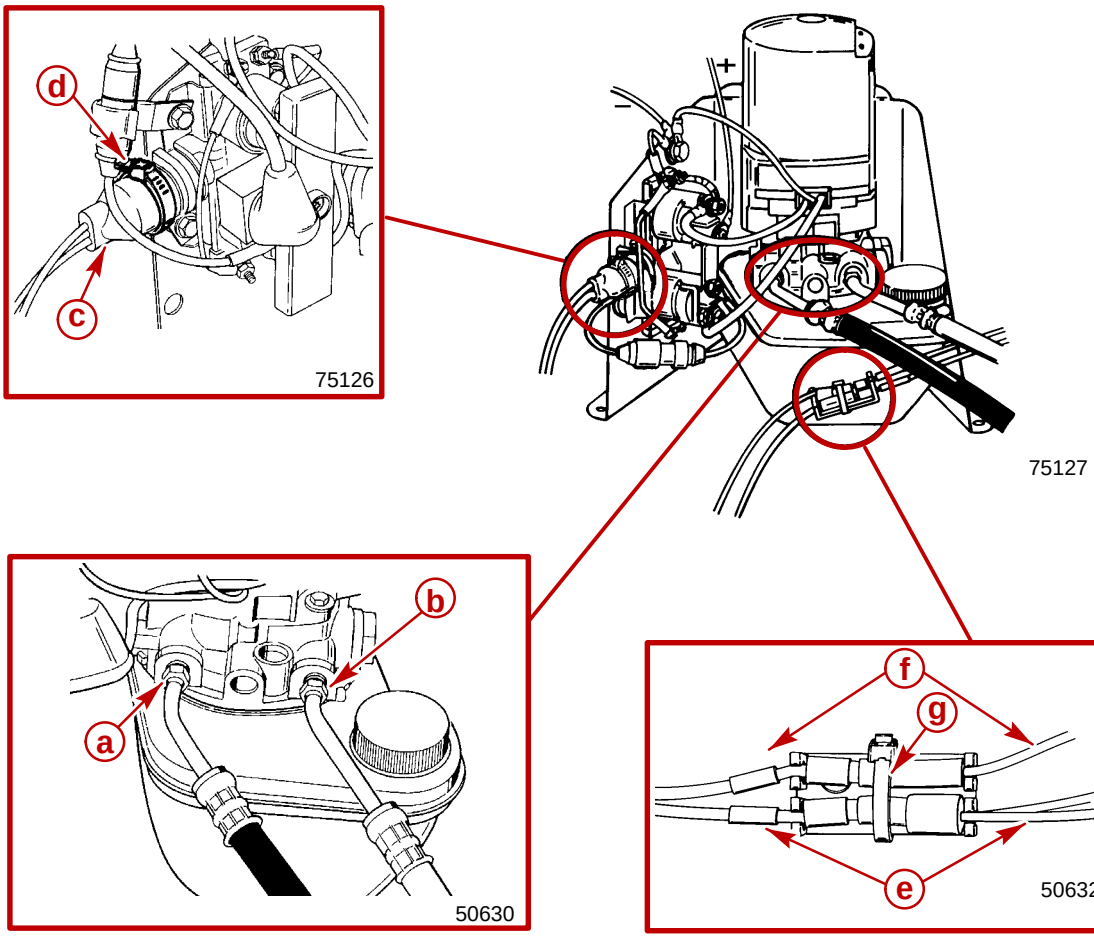
Power Trim Pump Connections

IMPORTANT: Make the hydraulic connections as quickly as possible to prevent oil from leaking out of the system. Be careful not to cross-thread or overtighten the hose fittings.

1. Connect the hydraulic hoses to the trim pump. Torque the fittings.

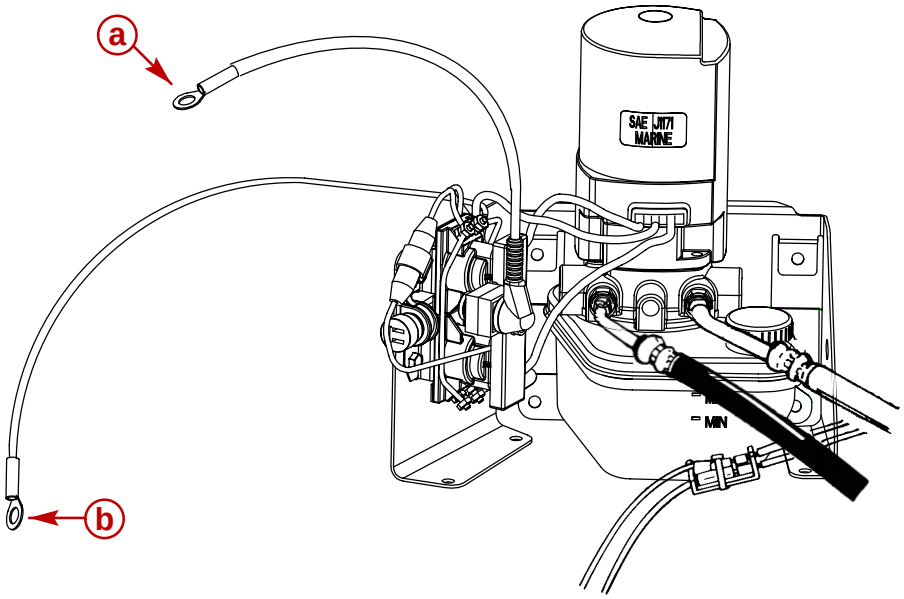
Description	Nm	lb-in.	lb-ft
Power trim pump hose fittings	14	125	

2. Connect the power trim pump control harness to the trim pump.
3. Connect the trim limit switch wires and secure with the wire retainer and tie strap.



a - Black hose fitting (UP circuit)
b - Gray hose fitting (DOWN circuit)
c - Control harness
d - Tie strap
e - Trim limit switch wire (with blue sleeve) to BLUE/WHITE harness wire
f - Trim limit switch wire (with purple sleeve) to PURPLE/WHITE harness wire
g - Wire retainer and tie strap

4. Connect the power trim pump wires to the battery.



76631

a - Positive battery lead
b - Negative battery lead

Fluid Connections

Fuel

IMPORTANT: The following information is provided to ensure proper installation of brass fittings or plugs installed into fuel pump or fuel filter base:

- **Use Loctite 565 PST on threads of fuel inlet fittings or plugs. DO NOT USE TEFLON TAPE.**
- **Fuel inlet fittings or plugs should first be threaded into fuel pump or fuel filter base until hand-tight.**
- **Then tighten the fuel inlet fittings or plugs an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVERTIGHTEN.**
- **To prevent over-tightening when installing a fuel line, hold the brass fittings with a suitable wrench as fuel inlet fittings are tightened securely.**

⚠ WARNING

Always adhere to all applicable Marine Regulations [United States Coast Guard (USCG), European Union - Recreational Craft Directive (EU-RCD), and so on] and the standards they reference [American Boat and Yacht Council (ABYC), Society of Automotive Engineers (SAE), International Standards Organization (ISO), and so on] when installing the fuel delivery system.

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

1. Apply sealant to threads of fuel inlet fitting. DO NOT USE TEFLON TAPE.

Description	Where Used	Part Number
Loctite 565 PST	Fuel inlet fitting	Obtain locally

2. Install fuel inlet fitting and tighten. To prevent cracking the casting or causing fuel leaks, follow the tightening procedures. DO NOT OVERTIGHTEN.

Description	Nm	lb-in.	lb-ft
Fuel inlet fitting	Hand-tight + 1-3/4 to 2-1/4 turns with a wrench. Do not overtighten.		

3. Open the fuel shut off valve, if equipped.

Standard Gear Lube Monitor Hose

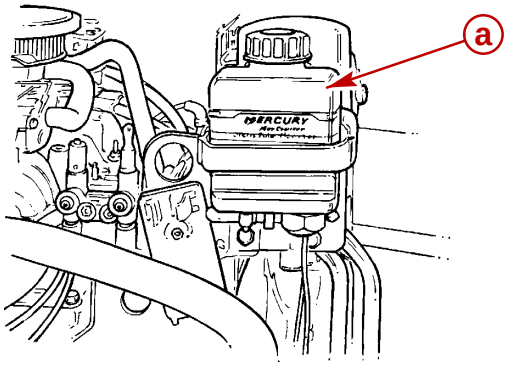
IMPORTANT: Avoid using excessive hose when routing it to the gear lube monitor. Route the hose directly to the oil reservoir in as straight a line as possible to avoid low spots (traps) in the system.

⚠ CAUTION

Ensure that the hose is not kinked when connecting . If the hose is kinked, the gear lube monitor will not function properly and damage to the sterndrive unit could occur.

1. Route the hose to the gear lube monitor and cut off the excess hose. Connect the hose and secure with a hose clamp.

IMPORTANT: The hose must not come in contact with the steering system components, the engine coupler, the U-joint shaft, or the drive shaft.



77813

a - Gear lube monitor

Gear Lube Monitor Hose With Quick Connect

IMPORTANT: Avoid using excessive hose when routing it to the gear lube monitor. Route the hose directly to the oil reservoir in as straight a line as possible to avoid low spots (traps) in the system.

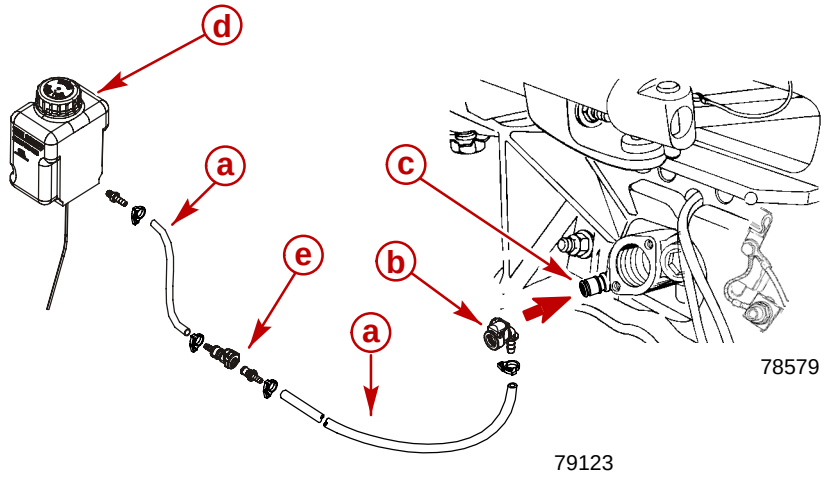
⚠ CAUTION

Ensure that the hose is not kinked when connecting . If the hose is kinked, the gear lube monitor will not function properly and damage to the sterndrive unit could occur.

1. Locate the white gear lube monitor quick connect at the rear of the engine.

IMPORTANT: Hose must not come in contact with steering system components, engine coupler, U-joint shaft, or drive shaft.

2. Fasten the quick connect between the engine portion and the transom portion of the gear lube monitor hose.



78579

79123

a - Hose
b - Quick release 90 degree fitting
c - Gimbal housing fitting
d - Gear lube monitor
e - Quick connect fitting

Power Steering Hoses

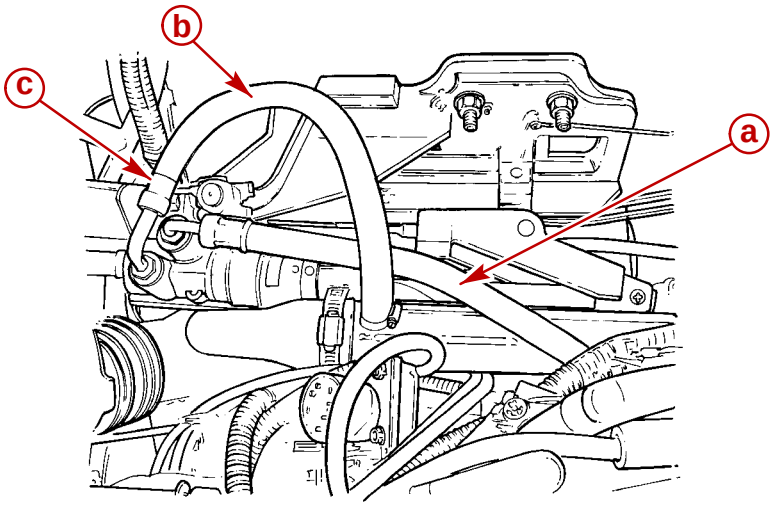
⚠ CAUTION

Route the hoses exactly as specified. This will help avoid stress on the hose fittings and will help avoid kinks in the hose.

IMPORTANT: Make the hydraulic connections as quickly as possible to prevent fluid leakage.

IMPORTANT: Be careful not to cross-thread or overtighten the fittings.

1. Route the hoses. Secure the hoses to avoid contact with moving components.
2. Connect the power steering hoses to the control valve. Torque both fittings.



77845

a - Rear fitting (pressure hose)
b - Front fitting (return hose)
c - Control valve

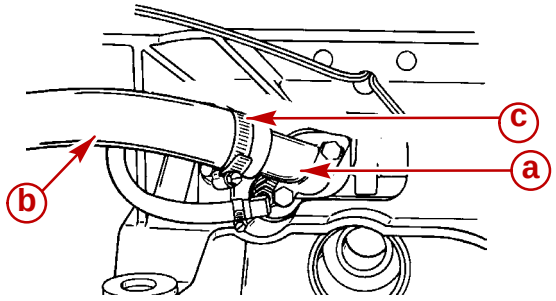
Description	Nm	lb-in.	lb-ft
Power steering hydraulic hose fittings	34		25

3. Use extra hose clips to secure the hose to the transom.

NOTE: *Power steering fluid can be added at this point, if desired.*

Bravo Models and Alpha Seawater Cooled Models Using Sterndrive Water Pickups

1. Connect water hose to water inlet fitting.
2. Secure with hose clamp.



72040

a - Water inlet fitting
b - Hose
c - Hose clamp

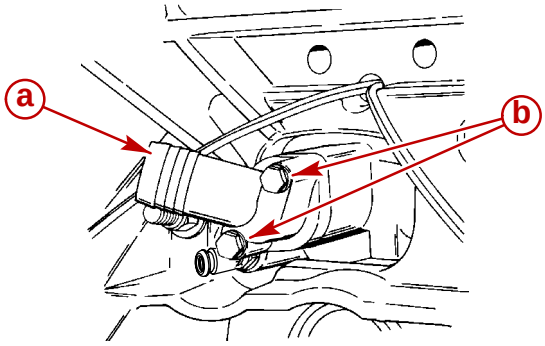
Alpha or Bravo Models Using Alternative Water Pickups

A water inlet block-off kit must be used if the sterndrive unit water pickup will not be used to supply water to the engine. When installing the block-off plate, it is necessary to cut the water hose that is located between the bell housing and the gimbal housing. This allows water to continue to circulate through the sterndrive unit for cooling.

⚠ CAUTION

Avoid overheating the sterndrive unit. The seawater inlet holes must be allowed to flow water without being obstructed or overheating damage to sterndrive may result. Do not dead-end seawater hose from bell housing. Cut hose as recommended in procedures.

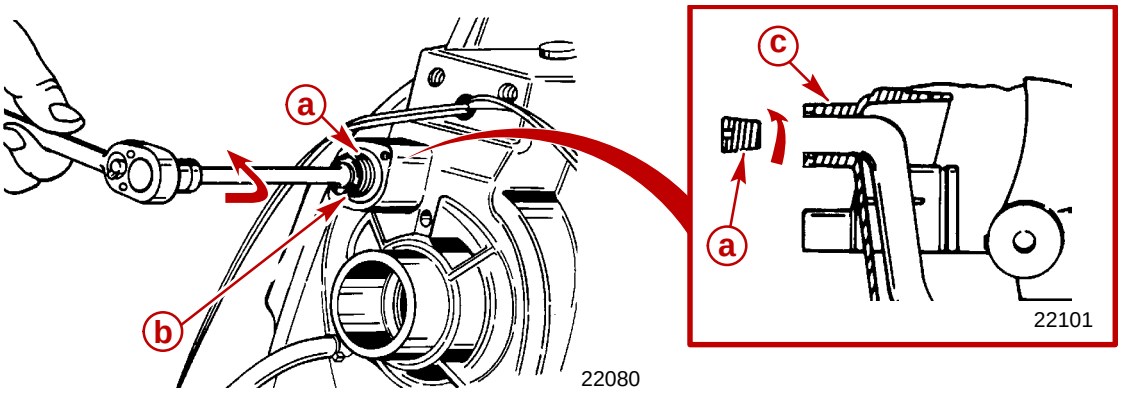
1. Remove the existing water fitting and gasket. Discard the screws and lockwashers.



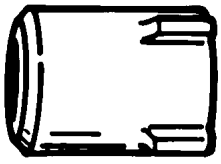
50663

a - Water fitting
b - Screws and lockwashers

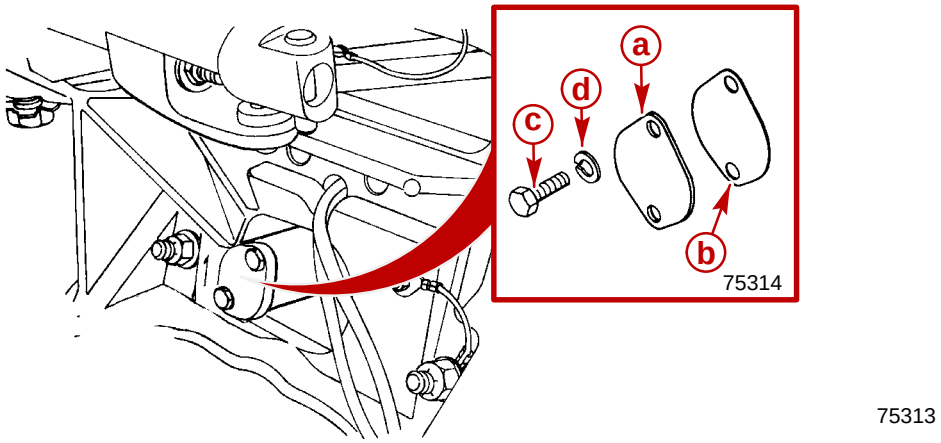
2. Remove the tapered insert in the gimbal housing using the Tapered Insert Tool. Discard the insert.



a - Tapered insert
b - Tapered Insert Tool
c - Gimbal housing cross-sectional view

Tapered Insert Tool		
 73456	Installs the tapered insert retainer into the water inlet hose on all the Bravo and Blackhawk sterndrive units.	91-43579

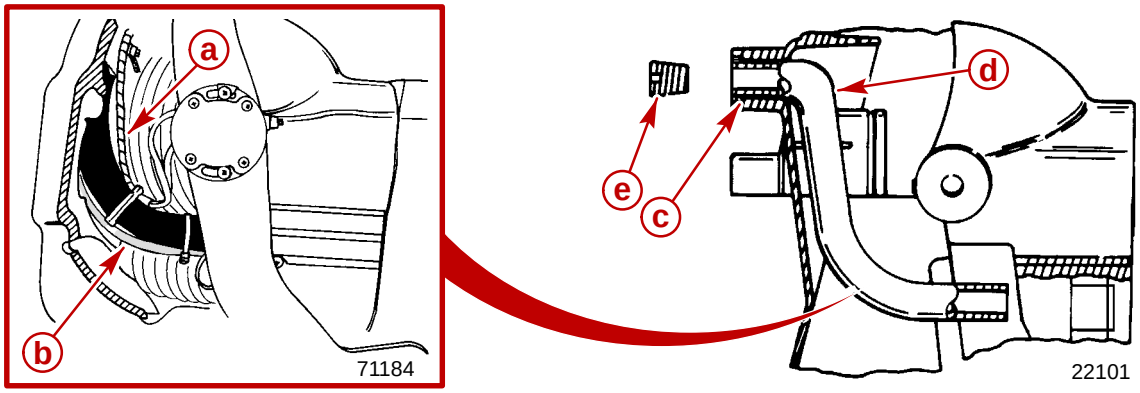
3. Install the block-off plate with new gasket. Secure with screws and lockwashers. Torque the screws.



a - Block-off plate
b - Gasket
c - Screw
d - Lockwasher

Description	Nm	lb-in.	lb-ft
Exhaust block-off plate screw	34		25

4. Move the trim limit switch wires and speedometer hose aside. Reach between the gimbal housing and the bell housing and detach the water hose from the gimbal housing where the tapered insert was removed in Step 2.



a - Trim limit switch wires
b - Speedometer hose
c - Gimbal housing
d - Water hose
e - Tapered insert

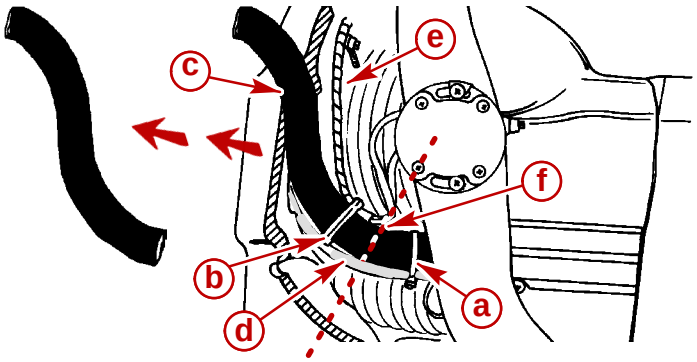
⚠ WARNING

Avoid water leakage into boat. Damage to U-joint bellows could result in water entering the boat. Do not damage the U-joint bellows when removing a section of the water hose attached between the gimbal housing and bell housing.

NOTE: *Move the trim limit switch wires and speedometer hose to avoid damaging them when cutting the water hose. The existing tie strap and clip can be reused if they are moved and repositioned after the hose is cut.*

5. Cut completely through the water hose 127 mm (5 in.) in front of the aft end of the hose where it is fitted into the bell housing. in the area shown. Do not damage the U-joint bellows. Discard loose hose piece.

6. Secure the trim limit switch wires and speedometer hose to the remaining section of water hose using existing tie strap and clip.



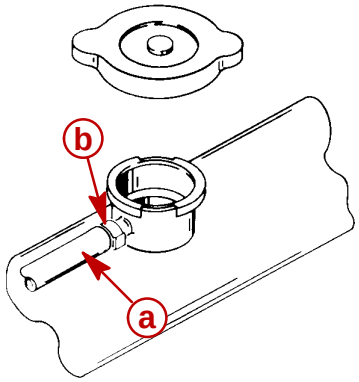
a - Tie strap
b - Clip
c - Water inlet hose
d - Speedometer hose
e - Trim limit wire harness
f - Cutting area

Coolant Recovery Bottle

⚠ CAUTION

Avoid engine overheating and subsequent damage to the engine. The coolant recovery system will not operate properly without proper sealing. The plastic tubing MUST seal *completely* at the connections.

1. Connect the plastic tubing to the bayonet fitting on the heat exchanger. Secure with the tubing clamp provided.



70548

a - Plastic tubing
b - Tubing clamp

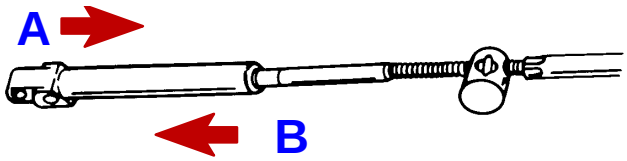
2. Remove the cap from the coolant recovery reservoir and fill to the FULL mark with coolant solution. Reinstall the cap.
3. Recheck the coolant level after the first open-throttle boat test and add coolant, if necessary.
4. Maintain the coolant level in the coolant recovery reservoir between the ADD and FULL marks with the engine at normal operating temperature.

Shift Cable Installation

NOTE: Bravo Models Only: *Using Adjustment Tool (91-12427), shift cables can be adjusted without or with the sterndrive installed.*

IMPORTANT: Sterndrive unit propeller rotation is determined by the shift cable installation in the remote control.

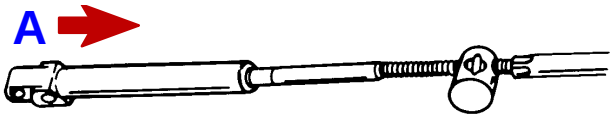
- **Alpha and Bravo One/Two - If shift cable end guide moves in direction A when control lever is placed in FORWARD, remote control is set up for right-hand (RH) propeller rotation.**
- **Alpha and Bravo One/Two - If shift cable end guide moves in direction B when control lever is placed in FORWARD, remote control is set up for left-hand (LH) propeller rotation.**



71656

Arrow indicates direction of motion

- **Bravo Three - Front propeller on sterndrive unit is always LH Rotation and rear propeller is always RH Rotation. Shift cable end guide must move in direction A, when control lever is placed in FORWARD gear position.**



71656

IMPORTANT: When installing shift cables, route to avoid sharp bends and/or contact with moving parts. Do not fasten any items to shift cables.

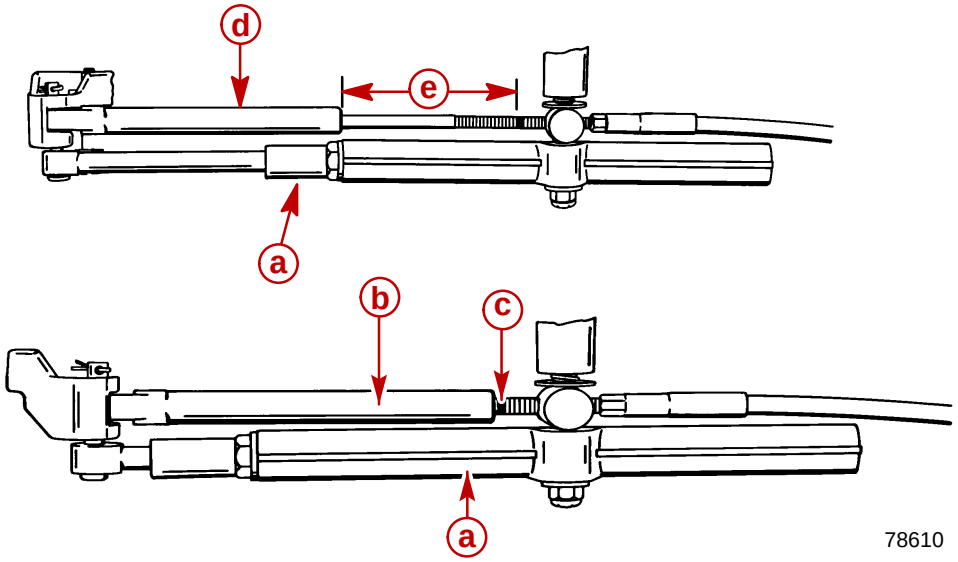
Alpha Models

SHIFT CABLE TRAVEL

We recommend the use of a Quicksilver remote control and cable. Refer to ***Mercury Precision Parts / Quicksilver Accessories Guide*** for selection. However, if a control other than Quicksilver is to be used, control must provide a shift cable travel (at the shift plate end) of 73 mm (2-7/8 in.) to 80 mm (3-1/8 in.) with a 6.8-9 kg (15-20 lb) load applied to the cable end guide.

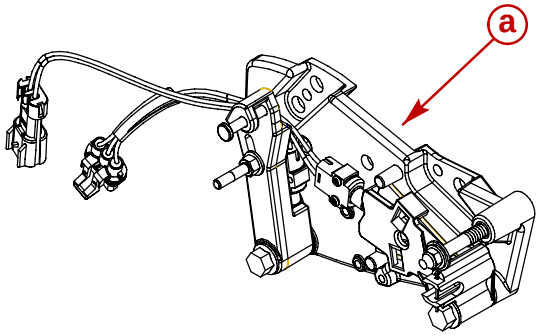
NOTE: *On engines with Alpha drives, the measurement specified can be taken by installing the remote control shift cable and using the shift assist assembly (provided) to place the proper load on the shift cable.*

1. Place a mark on the tube against the edge of the cable end guide.



78610

a - Shift assist assembly
b - Remote control shift cable - in FORWARD gear position
c - Mark on tube at edge of cable end guide
d - Remote control shift cable - in REVERSE gear position
e - Measurement taken from mark to edge of cable end guide: 73 mm (2-7/8 in.) to 80 mm (3-1/8 in.)



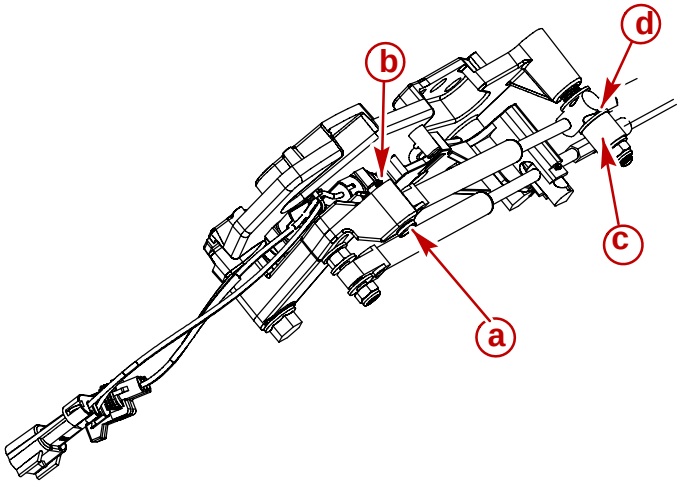
77988

a - Alpha shift plate

SEPARATE SHIFT AND THROTTLE CONTROLS

IMPORTANT: If boat is being equipped with a REMOTE CONTROL THAT HAS SEPARATE SHIFT AND THROTTLE LEVERS, the shift assist assembly that is shipped with the engine should NOT be used. The use of the shift assist assembly with this type of remote control can cause the shift lever to move out of gear unexpectedly.

Order spacer kit (23-11284A1) to connect remote control shift cable when shift assist assembly is not used.



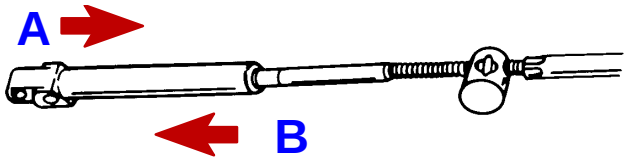
78492

a - Clevis pin
b - Washer
c - Spacer
d - Cotter pin

NOTE: *Do not discard shift assist assembly until after it is used below.*

IMPORTANT: Shift cable must be connected at the remote control for the appropriate rotation (LH or RH) drive unit, as explained following:

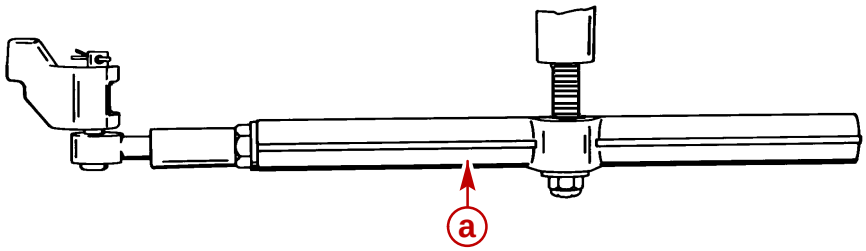
1. **Right–hand rotation** Control cable will have to be installed in remote control so that cable end will move in direction "**A**" when shift handle is placed in the FORWARD position.
2. **Left-hand rotation** Control cable will have to be installed in remote control so that cable end will move in direction "**B**" when shift handle is placed in the FORWARD position.



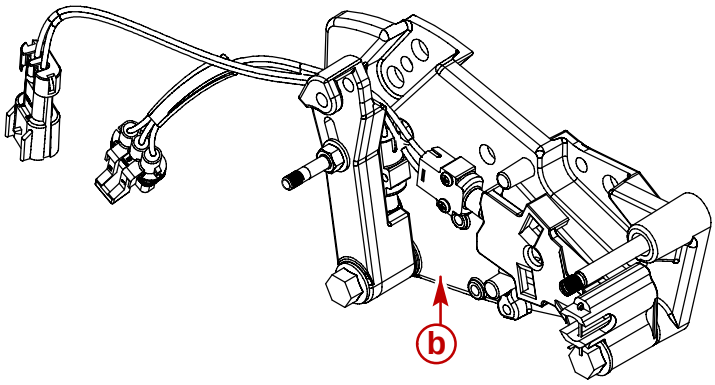
71656

INSTALLATION

1. Remove shift assist assembly.
2. Remove shift cable attaching hardware.



78545

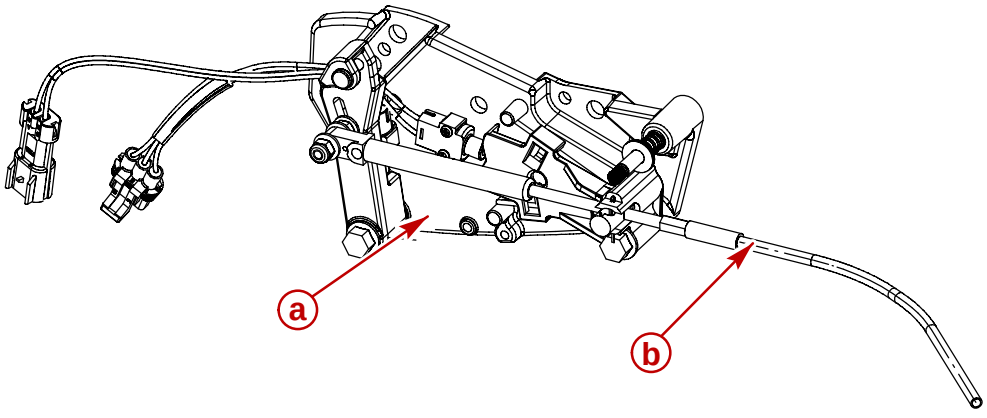


78542

Typical

a - Shift assist
b - Shift plate

3. Install intermediate cable.



78494

Typical

a - Shift plate
b - Intermediate cable

4. Secure the brass barrel retainer with the cotter pin or hair pin and spread both ends of cotter pin.
5. Secure the cable end guide with washers (1 on each end of the end guide) and locknut or hairpin.
6. If equipped with a locknut, tighten the locknut until it contacts and then loosen 1-1/2 turn.
7. Locate center of remote control and control cable play (backlash).

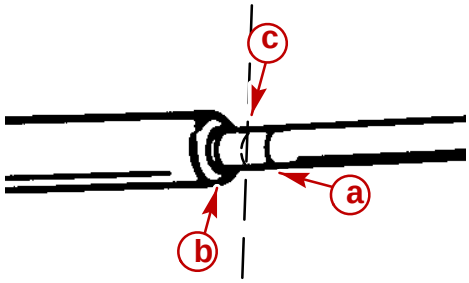
IMPORTANT: Keep center mark "c" aligned with control cable end guide edge when making the following adjustment.

a. Shift remote control to NEUTRAL.

b. Push in on control cable end with enough pressure to remove play and mark position "a" on tube.

c. Pull out on control cable end with enough pressure to remove play and mark position "b" on tube.

d. Measure distance between marks "a" and "b" and mark position "c" half-way between marks "a" and "b."



71656

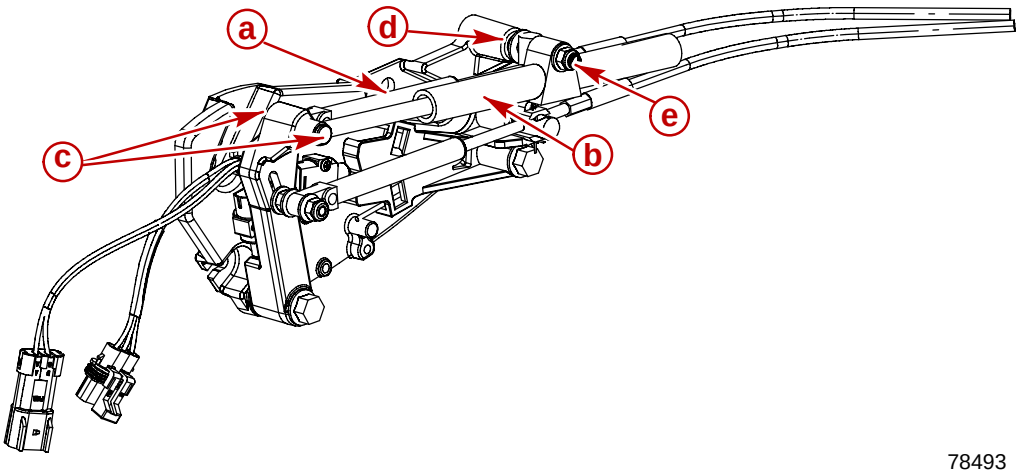
8. Temporarily install control cable end guide into shift lever and insert anchor pin.
9. Adjust control cable barrel so that hole in barrel centers with vertical centerline of stud. Ensure that backlash center mark is aligned with edge of control cable end guide.

⚠ CAUTION

Do not attempt to install or remove control cable barrel from stud without first removing end guide anchor pin from shift lever and removing cable. Attempting to bend control cable to install or remove barrel will place undue stress on cable end guide and shift lever and damage to both could occur.

10. Place remote control and and sterndrive unit in FORWARD gear.
11. Install the remote control shift cable.
12. Place remote control handle in NEUTRAL.
13. Install the shift assist assembly. Ensure that it fits over the clevis pin and barrel stud with no resistance.

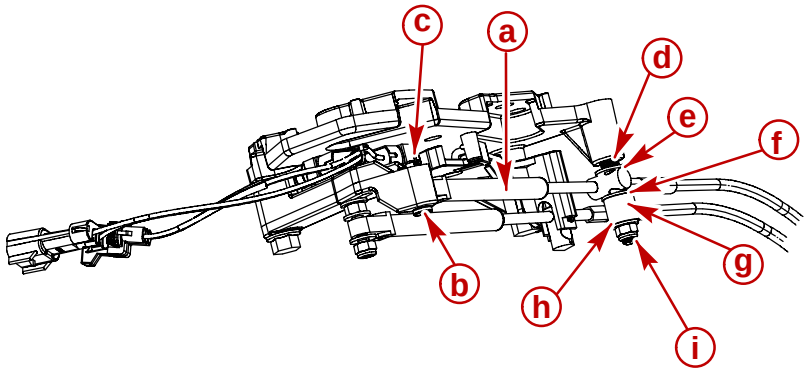
14. Install the fastening hardware. If shift assist assembly attaching points will not align, verify controller is in NEUTRAL. Remove the shift cable and reposition the adjustment barrel as required to allow the shift assembly to be installed with no effort.



78493

With shift assist assembly

- **a** - Remote control shift cable
- **b** - Shift assist assembly
- **c** - Clevis pin and cotter pin or hair pin
- **d** - Large ID washer
- **e** - Small ID washer and locknut or hair pin



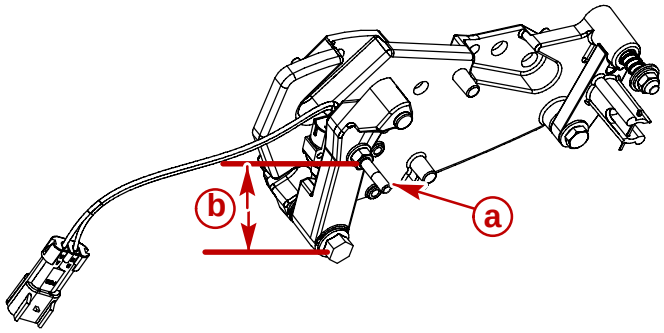
78495

Without shift assist assembly

- **a** - Remote control shift cable
- **b** - Clevis pin
- **c** - Cotter pin or hair pin (existing)
- **d** - Spring (existing)
- **e** - Washer (existing)
- **f** - Washer
- **g** - Spacer
- **h** - Washer (existing)
- **i** - Locknut or hair pin (existing)

Bravo Models

1. Loosen the adjustable stud and move it to dimension, as shown. Retighten stud.

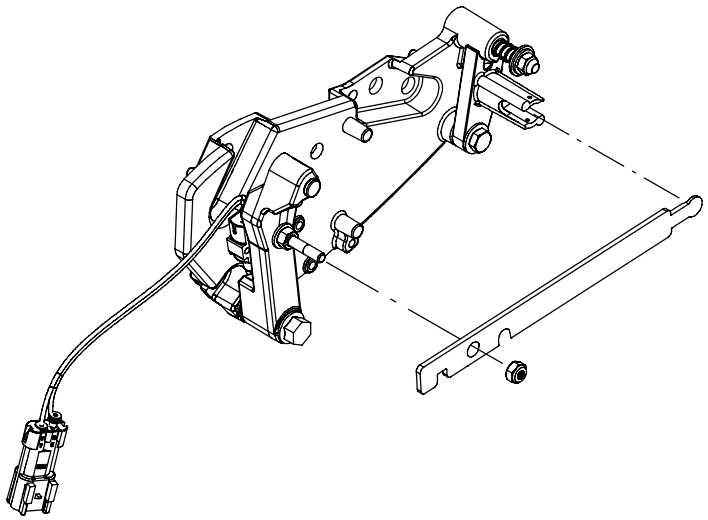


78496

Typical

a - Adjustable stud
b - 76 mm (3 in.) (center of pivot bolt to center of stud)

2. Remove the adjustment tool.

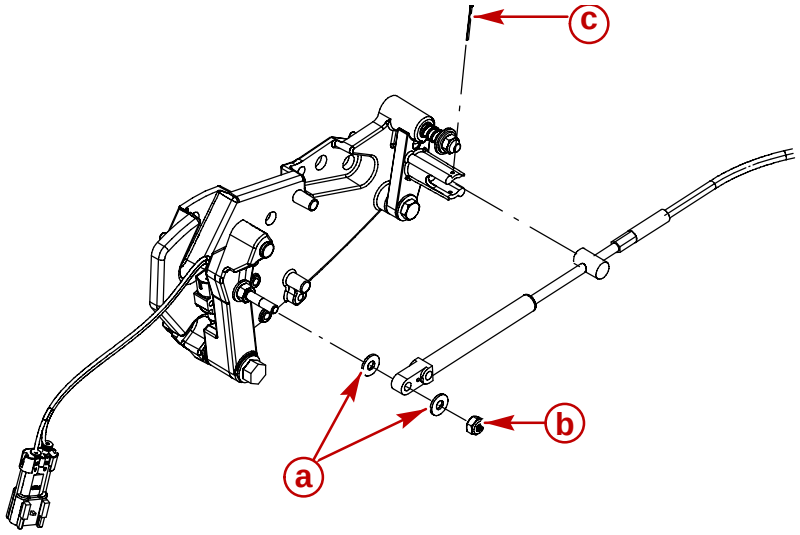


78544

Typical

3. Install sterndrive unit shift cable.
4. Tighten locknut until it contacts and then loosen 1-1/2 turns or install hair pin.

5. Insert cotter pin or hair pin from top and spread ends of the cotter pin.

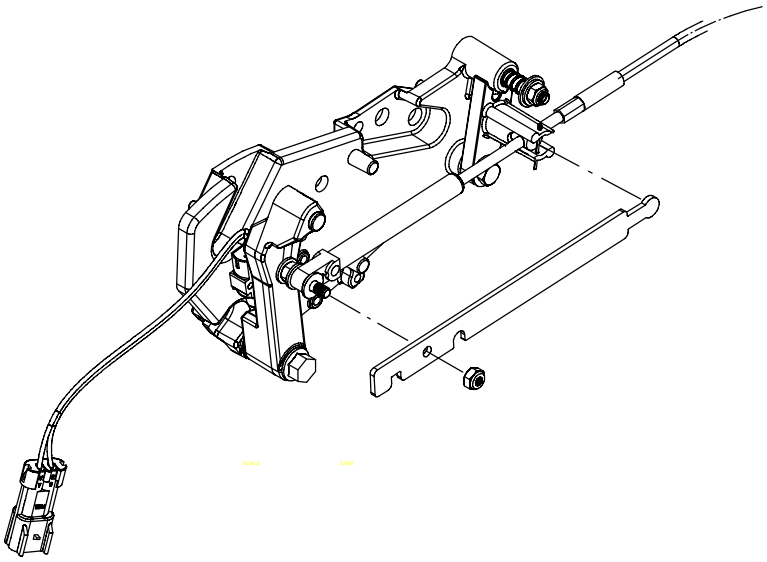


78609

Typical

a - Washers (2)
b - Locknut or hair pin
c - Cotter pin or hair pin

6. Place adjustment tool over sterndrive unit shift cable, as shown. Hold tool in place using a piece of tape over the barrel retainer.



78498

Typical

7. Locate center of remote control and control cable play (backlash).

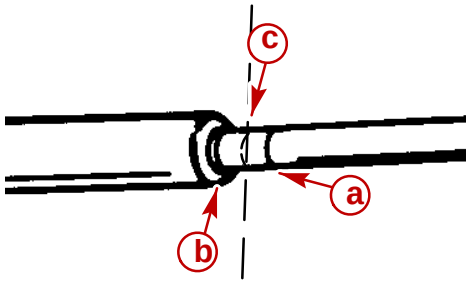
IMPORTANT: Keep center mark "c" aligned with control cable end guide edge when making the following adjustment.

a. Shift remote control to NEUTRAL.

b. Push in on control cable end with enough pressure to remove play and mark position "a" on tube.

c. Pull out on control cable end with enough pressure to remove play and mark position "b" on tube.

d. Measure distance between marks "a" and "b" and mark position "c" half-way between marks "a" and "b."



71656

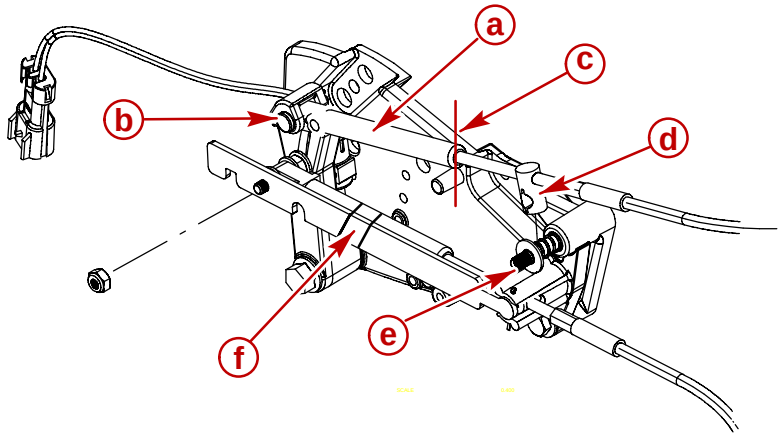
8. Temporarily install control cable end guide into shift lever and insert anchor pin.

9. Adjust control cable barrel so that hole in barrel centers with vertical centerline of stud. Ensure that backlash center mark is aligned with edge of control cable end guide.

⚠ CAUTION

Do not attempt to install or remove control cable barrel from stud without first removing end guide anchor pin from shift lever and removing cable. Attempting to bend control cable to install or remove barrel will place undue stress on cable end guide and shift lever and damage to both could occur.

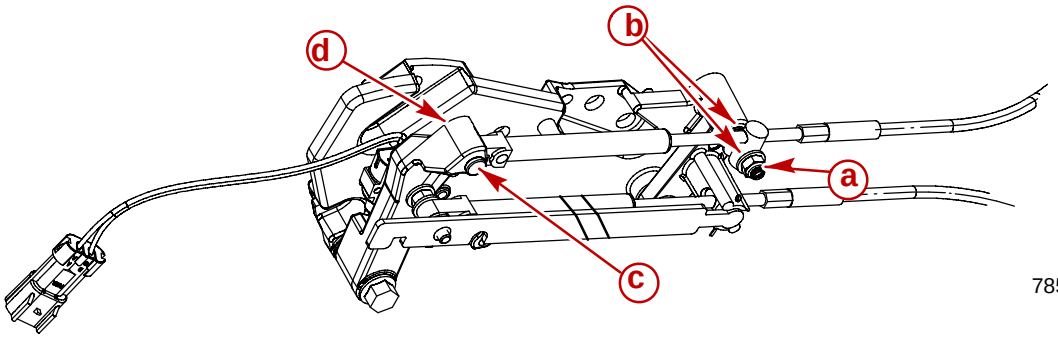
10. Remove control cable end guide from shift lever by removing clevis pin.



78499

a - Control cable end guide
b - Clevis pin
c - Backlash center
d - Control cable barrel
e - Stud
f - Tape

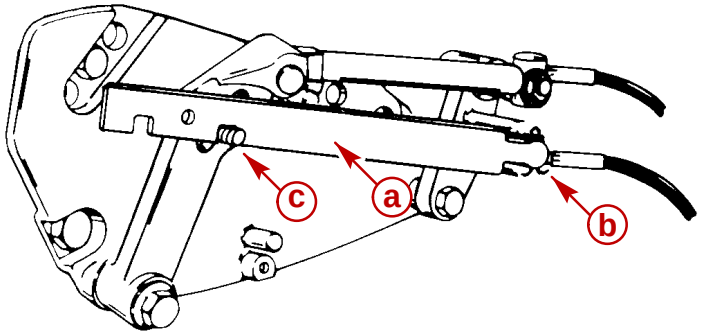
11. Install the control cable.
12. Install the washer and locknut hair pin.
13. If equipped with a locknut, tighten the locknut until it contacts and then loosen 1-1/2 turns.
14. Install the clevis pin.
15. Install the cotter pin or hair pin into the clevis pin from the top and spread the ends of the cotter pin.



a - Locknut or hair pin
b - Washers - both sides of barrel
c - Clevis pin
d - Cotter pin or hair pin(not shown)

16. Remove the adjustment tool.
17. Shift remote control lever into FORWARD position. Place end of adjustment tool in barrel retainer. If slot does not fit over stud, loosen shift lever stud and slide stud up or down until slot in tool fits over stud. When adjustment is correct, retighten stud.
18. Lift the adjustment tool so that the slot is above the stud.

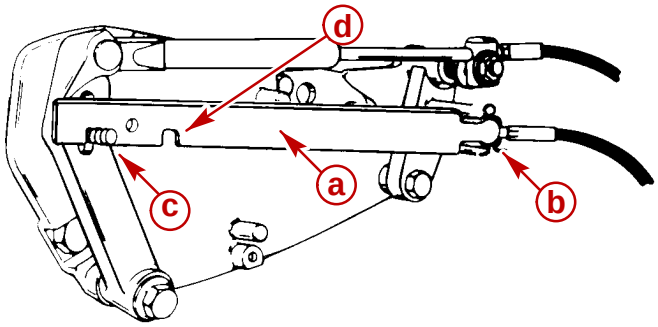
19. Shift the remote control into REVERSE and repeat the adjustment process.



71662

RH rotation Bravo One, Two, Three FORWARD

LH rotation Bravo One and Two REVERSE



71663

LH rotation Bravo One and Two FORWARD

RH rotation Bravo One, Two and Three REVERSE

a - Adjustment tool
b - Barrel retainer
c - Shift lever stud
d - Shift lever adjustment slot

20. Remove adjustment tool.
21. Lubricate shift cable pivot points.

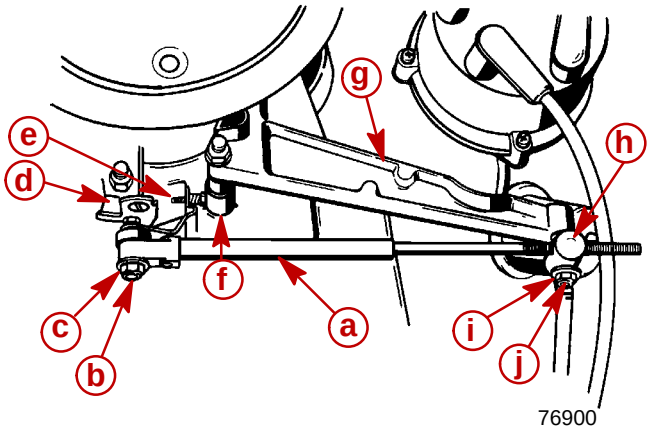
Description	Where Used	Part Number
SAE 30W Engine Oil	Shift cable pivot points	Obtain locally

Throttle Cable Installation and Adjustment

1. Place remote control handles in NEUTRAL/IDLE position.

IMPORTANT: Route cable to avoid sharp bends and/or contact with moving parts. Do not fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

2. Adjust cable so that it can be placed on both studs simultaneously.
3. Place cable over studs. Do not adjust cable after installation.
4. Secure throttle cable with hardware. Do not overtighten as cable must pivot freely. Tighten until nut contacts, then loosen 1/2 turn.
5. Place remote control throttle lever in the wide open throttle (WOT) position. Ensure that throttle shutters are completely open.
6. Return remote control throttle lever to idle position and ensure that throttle lever contacts idle speed adjustment screw.



2 BBL V8 models

a - Cable end guide
b - Throttle lever screw
c - Locknut and flat washer (small)
d - Throttle lever
e - Idle speed adjustment screw
f - Idle cam
g - Throttle bracket
h - Cable barrel
i - Flat washer and locknut (large)
j - Throttle cable anchor stud

Battery Connection

IMPORTANT: Engine electrical system is negative (–) ground.

1. Connect engine positive (+) battery cable (usually RED) to positive (+) battery terminal.
2. Connect engine negative (–) battery cable (usually BLACK) to negative (–) battery terminal.
3. Connect Power Trim pump BLACK (–) battery cable to negative (–) battery terminal and trim pump RED (+) battery cable to positive (+) battery terminal.
4. Ensure that all battery terminal connections are tight. Then, spray terminals with a battery connection sealant to help retard corrosion.

Description	Where Used	Part Number
Battery terminal sealant	Battery terminals	Obtain locally

Engine Cover Installation

1. Install the flame arrestor and secure with the bracket.
2. Torque the bolts.

Description	Nm	lb-in.	lb-ft
Flame arrestor bolts	12	108	

3. Install the engine cover and tighten the knob securely.

REMOVAL AND INSTALLATION

Section 2B - MIE Models

2 B

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Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Silicone Sealant	Screw shaft	Obtain locally
Marine Caulking	Seawater inlet mounting surfaces	Obtain locally
Loctite 271 Threadlocker	Seawater inlet nut	92-809819
Loctite 565 PST	Fuel inlet fitting	Obtain locally
	Seawater inlet hose fitting	
	Seawater inlet plastic plug	
	Fuel filter male threads	
2-4-C with Teflon	Shift cable end	92-802859A1
Special Lubricant 101	Steering cable end	92-802865A1
Liquid Neoprene	Battery terminals	92-25711-3
SAE 30W Engine Oil	Shift cable pivot points	Obtain locally
Perfect Seal	Water port inside diameter	92-34227-1
Liquid Soap	Exhaust tubes	Obtain locally

Equivalent products may be used.

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

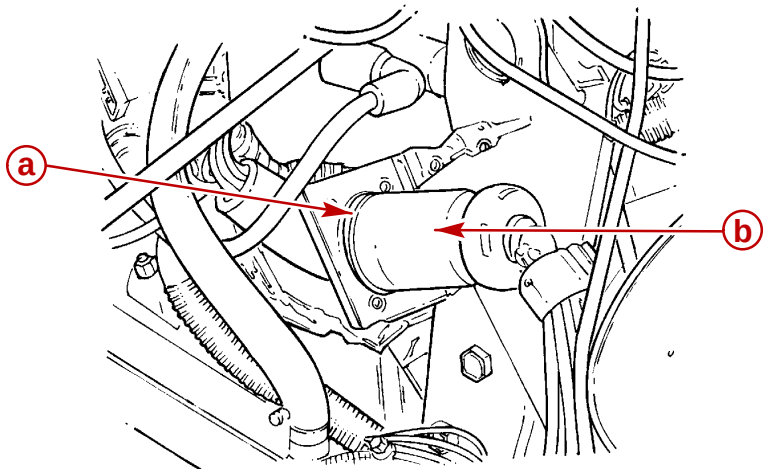
Description	Nm	lb-in.	lb-ft
Engine mount bracket screw	64		47
Trunnion clamping bolt and nut	68		50
Propeller shaft nut	68		50
Coupler bolt	68		50
Coupling bolts and nuts	68		50
Seawater pickup nut	42		35
Fuel line inlet fitting	Hand-tight + 1-3/4 to 2-1/4 turns with a wrench. Do not overtighten.		
Fuel filter connectors	19-27		14-20
Mounting clip screw	12	108	
Fuel line hose clamps	3.4-6.8	30-60	
Exhaust manifold screw	27		20
Flame arrestor bolts	12	108	
Transmission hydraulic hose fittings	34		25

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire, or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables from the battery.
2. Remove the engine cover.
3. Loosen the clamp and remove the instrument wiring harness plug from the engine wiring harness receptacle.



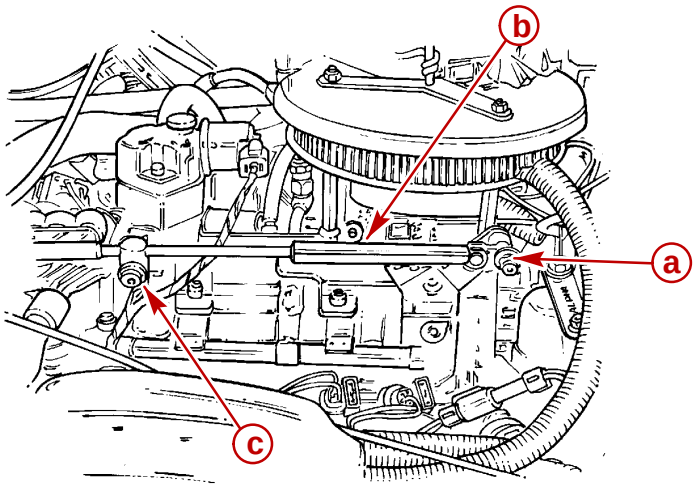
78031

a - Engine wiring harness receptacle
b - Instrument wiring harness plug

⚠ WARNING

Avoid extremely flammable and highly explosive conditions. Be careful when working on fuel systems. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

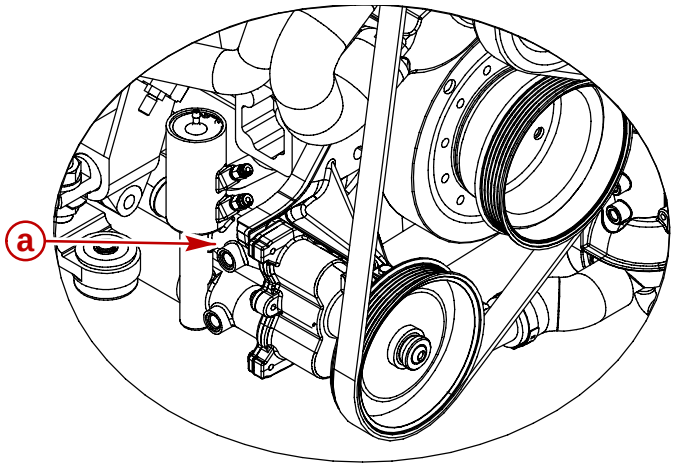
4. Loosen the hose clamp retaining the fuel line to the fuel inlet.
5. Close the fuel shut off, if equipped.
6. Disconnect and plug the fuel line to prevent fuel in the line from leaking into the bilge.
7. Disconnect the throttle cable and retain the fasteners.



78033

a - Washer and locknut
b - Cable barrel
c - Anchor plate

8. Disconnect the shift cable from the transmission.
9. Disconnect the seawater inlet hose from the seawater pump.



77844

a - Seawater inlet hose

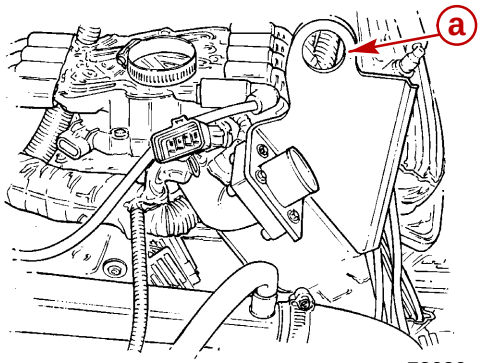
10. Disconnect the exhaust system hoses.
11. Disconnect any grounding wires and accessories that are connected to the engine.
12. Disconnect the propeller shaft coupler from the transmission output flange.
13. Disconnect the shaft log seal.

IMPORTANT: Engine compartment size may require the removal of additional components.

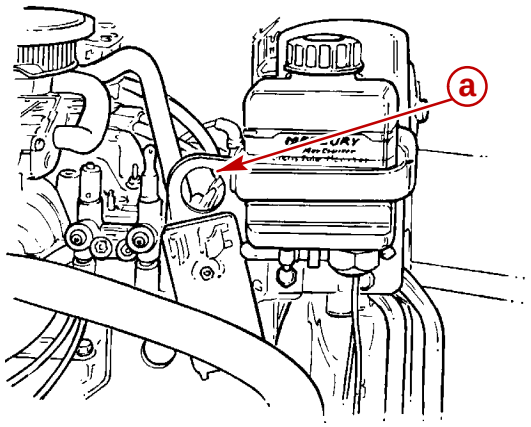
⚠ CAUTION

The engine MUST be lifted with a lifting arm or damage to engine components will occur. Do not allow the lifting sling to hook or compress the engine components or damage will occur.

14. Support the engine with a suitable sling through the lifting eyes on the engine.



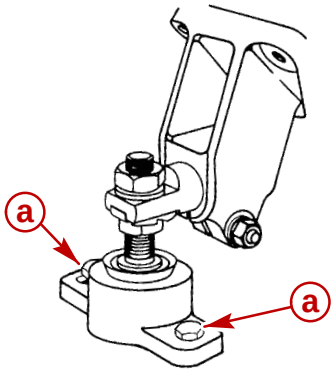
78030



77813

a - Engine lifting eyes

15. Remove the front and the rear engine mounting lag bolts. Retain the fasteners.



72638

a - Engine mounting lag bolt (with washers)

16. Carefully remove the engine.

Engine Mount Pre-Adjustment

IMPORTANT: The engine mounts must be adjusted, as explained in Steps 1. and 2., to center mount adjustment and establish a uniform height on all mounts.

1. Check all 4 engine mounts to ensure that the distance from the bottom of the mount to the bottom of the trunnion is as specified.

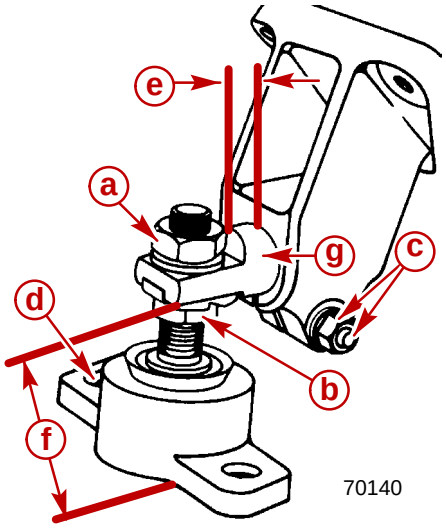
   a. If not, loosen the mount locking nut and turn the adjusting nut in the direction required to obtain the proper dimension, then retighten the locking nut.

Description	Specification
Distance from bottom of mount to bottom of trunnion	67 mm +/– 2 mm (2-5/8 in. +/– 1/16 in.)

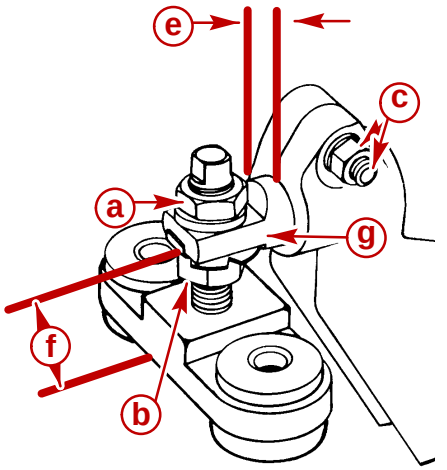
NOTE: *Leave the mount positioned so that the slot in the base is forward.*

2. Loosen the clamping bolts and the nuts on all 4 engine mount brackets to ensure that:

- The large diameter of the mount trunnion is extended.
- Mount base slotted mounting hole forward, if so designed.
- Each mount base is downward. Tighten the clamping bolts and the nuts slightly to prevent moving in or out. The mounts must be free to pivot when installing the engine.



Front mount



Rear mount

a - Locking nut
b - Adjusting nut
c - Trunnion clamp bolts and nuts, with lockwashers
d - Slot forward
e - 10 mm + 2 mm (3/8 in. + 1/16 in.)
f - 67 mm + 2 mm (2-5/8 in. + 1/16 in.)
g - Mount trunnion

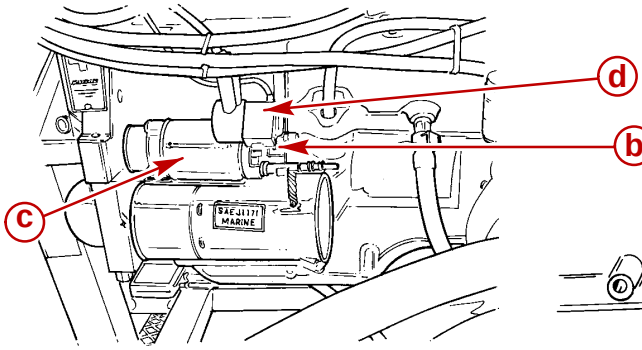
Engine Preparation

1. Ensure that the grounding stud and starter solenoid terminal are free of paint or any other material that could cause a poor electrical connection.
2. Connect the battery cables to the engine. Apply a thin coat of sealant to the terminals.

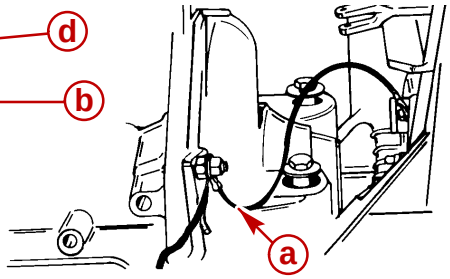
Description	Where Used	Part Number
Liquid Neoprene	Battery terminals	92-25711-3

3. Slide the rubber boot over the positive (+) terminal.
4. Drape battery cables over top of engine to prevent interference during installation.

IMPORTANT: There is a fuse located at the starter solenoid. Do not remove this fuse. The positive battery cable must be connected to the same stud as the fuse.



77907



71651

a - Negative (–) battery cable
b - Positive (+) battery cable (not shown)
c - Starter solenoid
d - 90 amp fuse - Do Not Remove

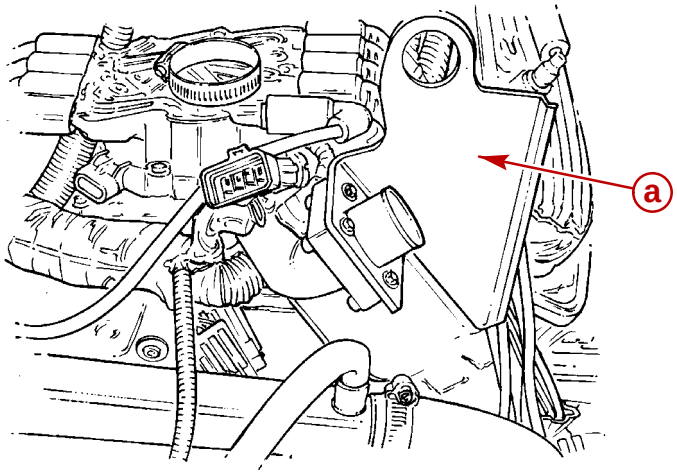
Engine Oil Dipstick Relocation (If Equipped)

On inboard engines, the crankcase oil dipstick can be located on either the starboard or the port side of the engine to suit installation requirements. To move the dipstick, remove the dipstick from the current location and install in the opposite side. Place the rubber cap over the open dipstick tube.

Engine Installation And Initial Engine Alignment

Models With 8 Degree Down Angle Transmissions - Velvet Drive Or ZF/Hurth

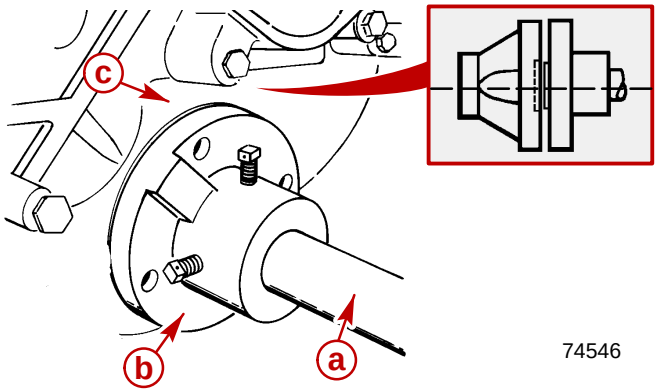
1. Lift the engine into the boat.
2. Install the quick drain oil hose plug in the oil drain hose.
3. Position the engine on the engine bed so that the transmission output flange and the propeller shaft coupler are visibly aligned (no gap can be seen between the coupling faces when butted together). **Adjust the engine bed height** if necessary to obtain proper alignment. Do not use the mount adjustments to adjust the engine position at this time.



78030

a - Rear lifting eye

IMPORTANT: The engine bed must position the engine so that a minimum of 6 mm (1/4 in.) up and down adjustment still exists on all 4 mounts after performing initial alignment. This is necessary to allow for final engine alignment.



74546

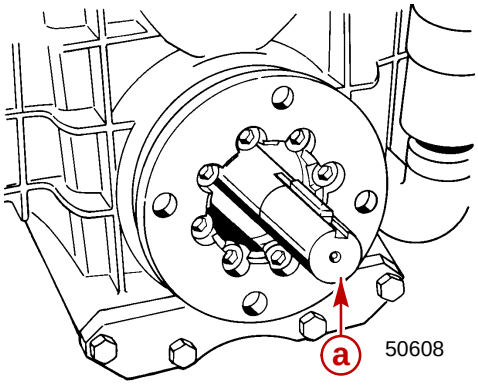
a - Propeller shaft
b - Propeller shaft coupler
c - Transmission output flange

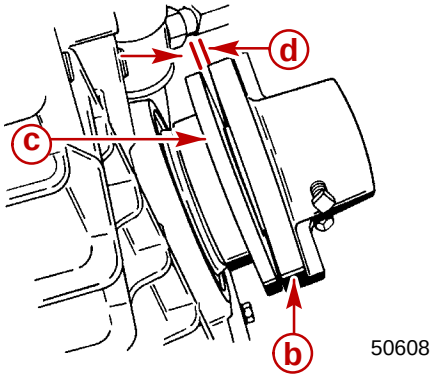
4. Ensure that all 4 mounts are still positioned properly, then fasten the mounts to the engine bed with 10 mm (3/8 in.) diameter lag bolts (of sufficient length) and flat washers. Tighten the lag bolts securely.
5. Disconnect the overhead hoist and remove the sling.

Models with V-Drive Transmissions

1. Lift the engine into the boat.
2. Install the quick drain oil hose plug in the oil drain hose.
3. Position the engine so that enough propeller shaft protrudes through the transmission and the output flange for the propeller shaft coupler to be attached. Then install the coupler and position the engine (no gap can be seen between the coupling faces when butted together). **Adjust the engine bed height** if necessary to obtain proper alignment. Do not use the mount adjustments to adjust the engine position at this time.

IMPORTANT: Engine bed must position the engine so that a minimum of 6 mm (1/4 in.) up and down adjustment still exists on all 4 mounts after performing initial alignment. This is necessary to allow for final engine alignment.





ZF/Hurth 630V shown, others similar

a - Propeller shaft
b - Propeller shaft coupler
c - Transmission output flange
d - **No Gap Allowed**

4. Ensure that all 4 mounts are still positioned properly. Fasten the mounts to the engine bed with 10 mm (3/8 in.) diameter lag bolts (of sufficient length) and flat washers. Tighten the lag bolts securely.
5. Disconnect the overhead hoist and remove the sling.

Exhaust System

⚠ CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damaged caused by the water in the engine will not be covered by Mercury MerCruiser Warranty, unless this damage is the result of defective parts.

Measuring Exhaust Elbow Height

The height of the exhaust elbows and the slope of the exhaust hoses must be within the dimensions specified to prevent water intrusion problems. Exhaust elbow risers must be installed, if needed, to obtain the proper height and/or slope. Measurement must be taken with the boat in the water. It is important that the boat be loaded as outlined following to simulate the maximum loading conditions likely to be encountered in normal operation.

IMPORTANT: Load distribution recommendations are the responsibility of the boat manufacturer. Any load distribution conditions that will affect the exhaust system height and slope compliance must be clearly communicated to the operator in the owner's manual. For example, the number of people that can be located on the swim platform simultaneously should be included in the manual, if this could pose a problem.

1. Fill fuel, water, gray water, and heater tanks to maximum capacity. People or weights can be used to simulate these loads if desired. Refer to conversions:

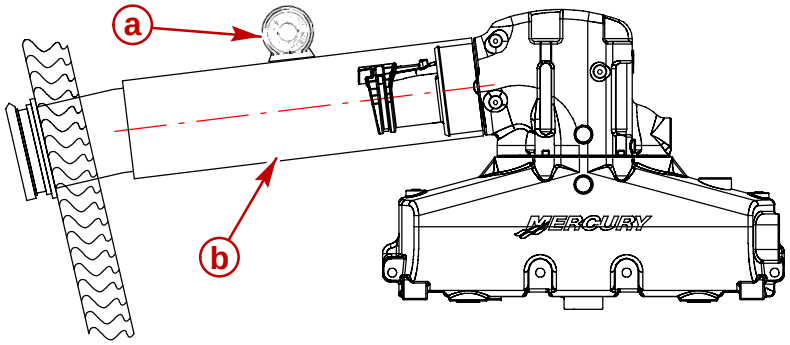
- 1 U.S. gallon of water = 8.3 lb
- 1 liter of water = 1 kg
- 1 U.S. gallon of gasoline = 6 lb
- 1 liter of gasoline = 0.72 kg

2. Add maximum allowable cargo weight to boat in areas where it will be stowed, including refrigerator and lockers. Do not forget the PWC, if applicable.
3. Add average passenger weight in all locations where each passenger will sit during normal operation.

NOTE: *ABYC specifies an average passenger weight of 64 kg (141 lb) for boat loading calculations. This should be used as a minimum. An average passenger weight of 86 kg (190 lb) is desirable.*

4. Measure exhaust elbow height as outlined under Methods For Measuring Exhaust Elbow Height. Also measure exhaust system slope as shown below.

NOTE: *Exhaust elbow height is measured to the water lift muffler (instead of the waterline) on applications so equipped. Refer to Water Lift Muffler.*



78710

a - Inclinometer
b - Exhaust hose

5. Leave fluid and cargo weights where they are, but remove passenger weights from boat. Beginning at the bow, reload passenger weight (the equivalent of one person at a time) while retaking readings. Use all of the available seating areas in the bow first. Continue adding passenger weight (and taking readings), moving from the bow to the stern until the maximum people weight has been added back on board.
6. Repeat Step 5, but this time start at stern of boat and work toward bow.
7. Measurements under all loading conditions should be within these specifications:

Minimum Exhaust Elbow Height	
Model	**Specification**
V8	33.0 cm (13 in.)

Minimum Exhaust Hose Slope		
Model	**Specification**	
	Within 45.7 cm (18 in.) of engine	Remainder of system (if applicable)
All models	10 degrees	3 degrees

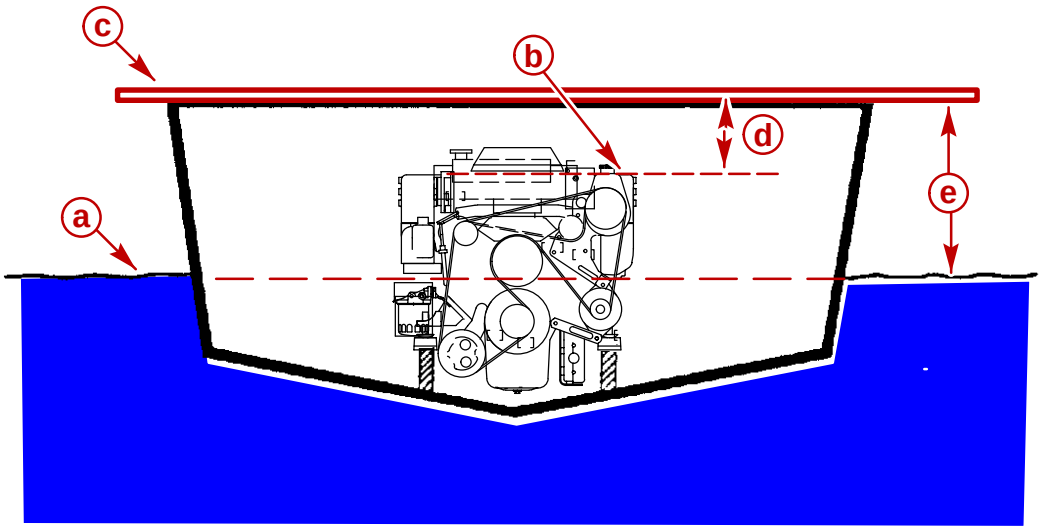
8. Install risers if height is insufficient. Modify exhaust system and/or install risers, if slope is insufficient. Refer to the ***Mercury Precision Parts / Quicksilver Accessory Guide*** for part numbers.

Riser Options		
Model	**Low**	**Medium**
V8	76 mm (3 in.)	152 mm (6 in.)

IMPORTANT: Refer to Measuring Exhaust Elbow Height for instructions on proper loading of the boat and complete measurement instructions.

STRAIGHT EDGE METHOD

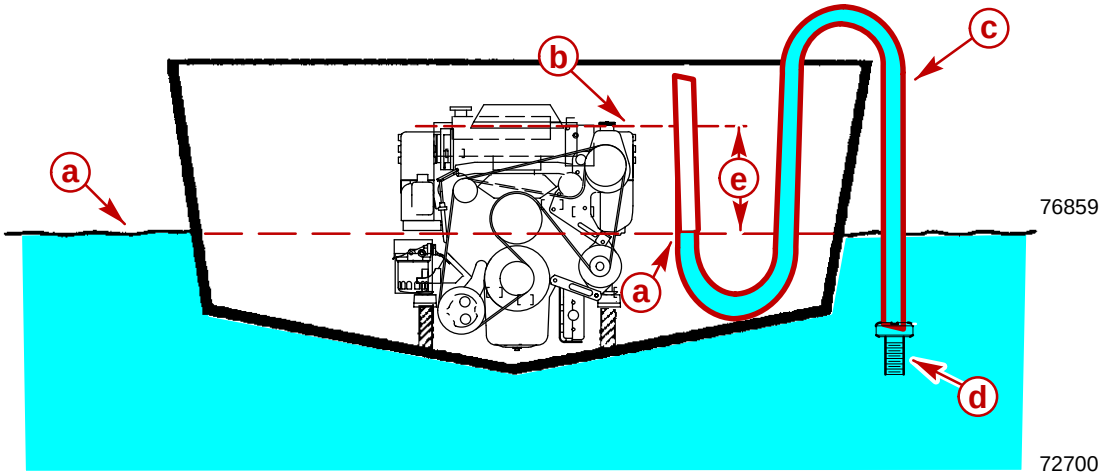
1. Place a straight edge across boat.
2. With the straight edge above the engine as shown, measure the distance between the straight edge and the top of the exhaust elbow.
3. Ensure that the boat is level from side-to-side, using a level or inclinometer. Then, measure the distance between the straight edge and the outside waterline.
4. The difference between these two measurements is the exhaust elbow height above the water line. Refer to Measuring Procedures and compare measurement to specifications.



a - Waterline
b - Top of exhaust elbow
c - Straight edge
d - Measurement between straight edge and top of exhaust elbow
e - Measurement between straight edge and water line

CLEAR HOSE METHOD

1. Obtain a 8-10 mm (5/16 - 3/8 in.) ID hose approximately 4.5 m (15 ft) long. Put a metal fitting or a weight on one end of the hose to keep that end of the hose below the waterline.
2. Put the weighted end of the hose over the port or starboard side of the boat, keeping it in line with the engine's exhaust elbow.
3. Route the remainder of the hose toward the engine's exhaust manifold and elbow. Ensure that this open end section of the hose is as vertical as possible from the boat's bilge to the top of the exhaust elbow
4. Coil excess hose in bilge of boat, keeping it below the water line.
5. Lower open end of hose and siphon water until it starts to come out of the hose. Put a finger over the hose and lift open end until it is at the top of the exhaust elbow.
6. Slowly take finger off end of hose to let the water level stabilize. The water will seek the level of the water outside the boat. Keep hose close to exhaust elbow and as vertical as possible.
7. Ensure that the boat is level (side-to-side) using a level or inclinometer.
8. The measurement between water in hose and top of exhaust elbow is the exhaust elbow height.



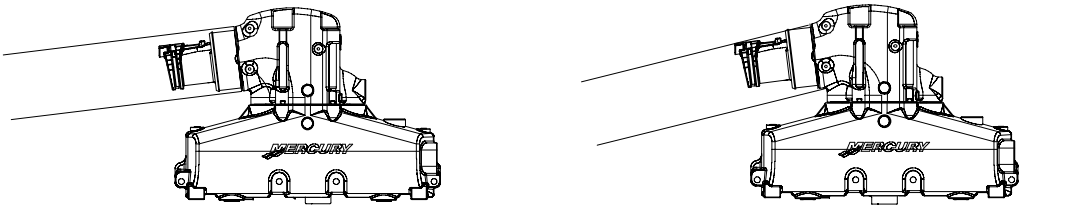
a - Waterline
b - Top of exhaust elbow
c - Clear plastic hose
d - Weight
e - Measurement - waterline to top of exhaust elbow

Exhaust System Hose / Tube Connections

⚠ CAUTION

Avoid exhaust hose failure. Discharge water from the exhaust elbow must flow around the entire inside diameter of the hose to avoid causing hot spots which could eventually result in burned-through exhaust hoses. The exhaust hoses and/or tubes must be correctly connected to the exhaust elbows so that they do not restrict the flow of discharge water from the exhaust elbow.

1. Install the exhaust hoses and tubes.
2. The exhaust hoses/tubes should be secured at each connection with at least 2 hose clamps.



78715

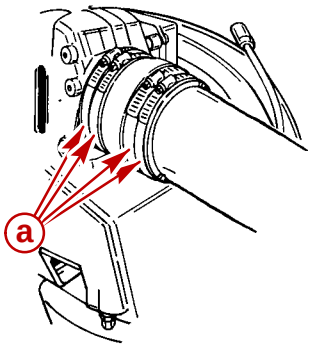
Correct **Incorrect**

IMPORTANT: Exhaust hoses/tubes should be secured at each connection with at least 2 hose clamps.

71653

Correct connection **Incorrect connection**

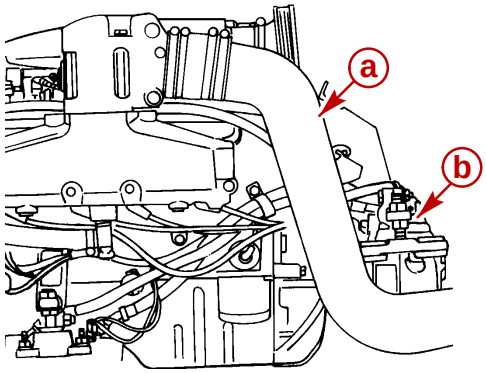
3. Tighten all hose clamps securely.



73961

a - Hose clamps

IMPORTANT: S-pipes must be routed under the transmission mounts.



74832

Tow Sports models

a - S-pipe
b - Transmission mount

Electrical Connections

MPI Electrical System Precautions

⚠ CAUTION

Avoid damage to the MPI electrical system components. Refer to the following precautions when working on or around the MPI electrical harness or when adding other electrical accessories.

- **Do not tap the accessories into the engine harness.**
- **Do not puncture wires for testing (Probing).**
- **Do not reverse the battery leads.**
- **Do not splice wires into the harness.**
- **Do not attempt diagnostics without proper, approved Service Tools.**

IMPORTANT: Route and secure all wire harnesses and hoses to avoid contact with hot spots and moving parts on the engine.

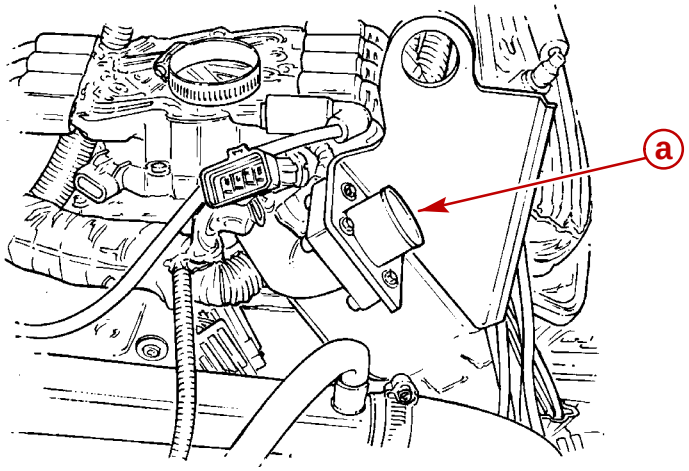
Instrumentation Connections

We recommend the use of Quicksilver Instrumentation and Wiring Harnesses which have been specifically designed for compatibility with our engines. Instrumentation wiring extension harnesses are available in several lengths. Refer to the ***Mercury Precision Parts / Quicksilver Accessories Guide*** for selection.

⚠ CAUTION

If a Quicksilver wiring harness is used and a fused accessory panel is to be installed (40-amp current draw maximum), connect it as shown in the wiring diagrams. Do not connect accessory panel at any other location as wires in the wiring harness may not be of sufficient size to handle the current load.

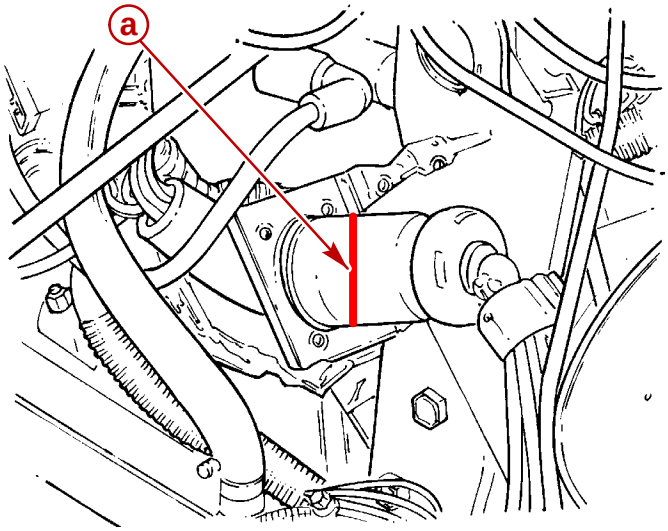
1. Connect the instrumentation wiring harness to the engine harness plug at the location shown.



78030

a - Engine wiring harness receptacle

2. Secure the harness with the hose clamp.



78031

a - Hose clamp location

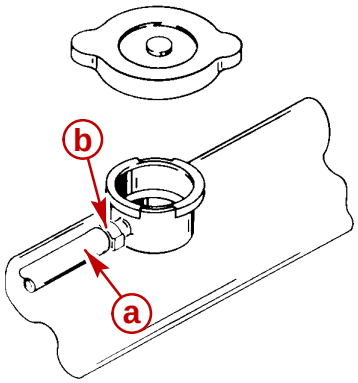
Fluid Connections

Coolant Recovery Bottle

⚠ CAUTION

Avoid engine overheating and subsequent damage to the engine. The coolant recovery system will not operate properly without proper sealing. Ensure that the plastic tubing seals *completely* at the connections.

1. Connect the plastic tubing to the bayonet fitting on the heat exchanger. Secure with a tubing clamp.



70548

a - Plastic tubing
b - Tubing clamp

2. Remove the cap from the coolant recovery reservoir and fill to the FULL mark with coolant solution. Install the cap.

Transmission Cooler

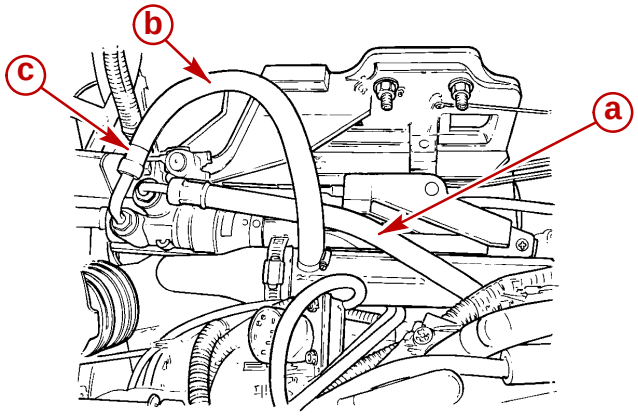
⚠ CAUTION

Route the hoses exactly as specified. This will help avoid stress on the hose fittings and will help avoid kinks in the hose.

IMPORTANT: Make the hydraulic connections as quickly as possible to prevent fluid leakage.

IMPORTANT: Be careful not to cross-thread or overtighten the fittings.

1. Route the hoses. Secure the hoses to avoid contact with moving components.
2. Connect the transmission hoses to the control valve. Torque both fittings.



77845

a - Rear fitting (pressure hose)
b - Front fitting (return hose)
c - Control valve

Description	Nm	lb-in.	lb-ft
Transmission hydraulic hose fittings	34		25

3. Use extra hose clips to secure the hose to the transom.

NOTE: *Power steering fluid can be added at this point, if desired.*

Fuel

IMPORTANT: The following information is provided to ensure proper installation of brass fittings or plugs installed into fuel pump or fuel filter base:

- **Use Loctite 565 PST on threads of fuel inlet fittings or plugs. DO NOT USE TEFLON TAPE.**
- **Fuel inlet fittings or plugs should first be threaded into fuel pump or fuel filter base until hand-tight.**
- **Then tighten the fuel inlet fittings or plugs an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVERTIGHTEN.**
- **To prevent overtightening when installing a fuel line, hold the brass fittings with a suitable wrench as fuel inlet fittings are tightened securely.**

⚠ WARNING

Always adhere to all applicable Marine Regulations [United States Coast Guard (USCG), European Union - Recreational Craft Directive (EU-RCD), and so on] and the standards they reference [American Boat and Yacht Council (ABYC), Society of Automotive Engineers (SAE), International Standards Organization (ISO), and so on] when installing the fuel delivery system.

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

1. Apply sealant to threads of fuel inlet fitting. DO NOT USE TEFLON TAPE.

Description	Where Used	Part Number
Loctite 565 PST	Fuel inlet fitting	Obtain locally

2. Install fuel inlet fitting and tighten. To prevent cracking the casting or causing fuel leaks, follow the tightening procedures. DO NOT OVERTIGHTEN.

Description	Nm	lb-in.	lb-ft
Fuel inlet fitting	Hand-tight + 1-3/4 to 2-1/4 turns with a wrench. Do not overtighten.		

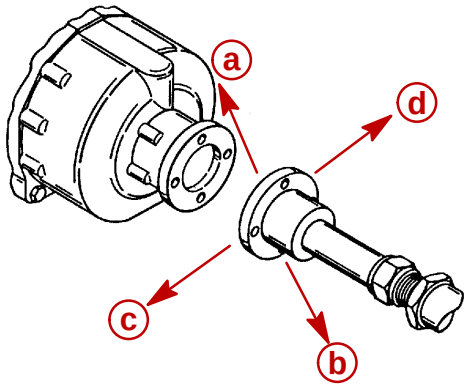
3. Open the fuel shut off valve, if equipped.

Final Engine Alignment

IMPORTANT: Engine alignment MUST BE RECHECKED with the boat in the water, fuel tanks filled, and a normal load on board.

The engine must be aligned so that the transmission and the propeller shaft coupling centerlines are aligned and the coupling faces are parallel within 0.07 mm (0.003 in.). This applies to installations with solid couplings as well as flexible couplings.

1. Check mating faces on the transmission output flange and the propeller shaft coupler to ensure that they are clean and flat.
2. Center the propeller shaft in the shaft log as follows:
   a. Push down then lift the shaft as far as it will move. Place the shaft in the middle of the movement.
   b. Move the shaft to port then to starboard as far as the shaft will move. Place the shaft in the middle of the movement.
   c. With the shaft in the center of the shaft log, as determined by above procedures, align the engine to the shaft.

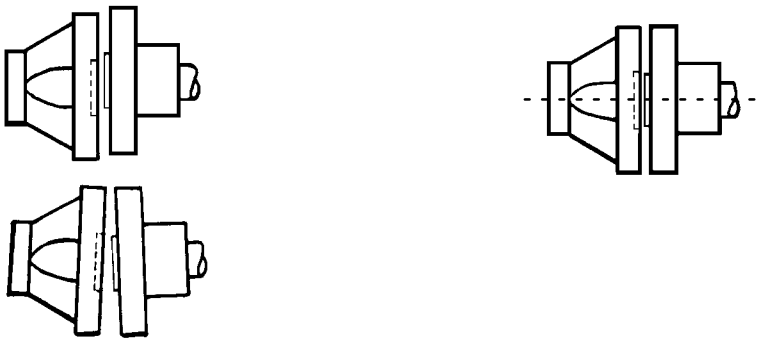


72595

Typical Down Angle shown, V-drive similar

a - Up
b - Down
c - Port
d - Starboard

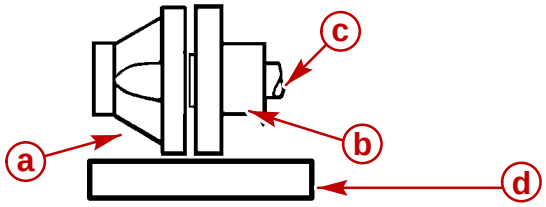
3. Ensure that the coupling centerlines align. Place the propeller shaft coupler against the transmission output flange. The shoulder on the propeller shaft coupler face should engage the recess on the transmission output flange face with no resistance.



72597

Incorrect **Correct**

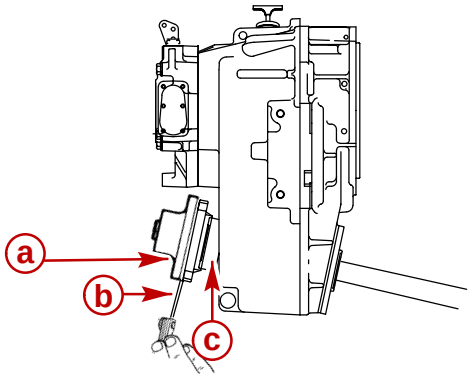
NOTE: *Some propeller shaft couplers may not have a shoulder on the mating face. On these installations, use a straightedge to check centerline alignment.*



74483

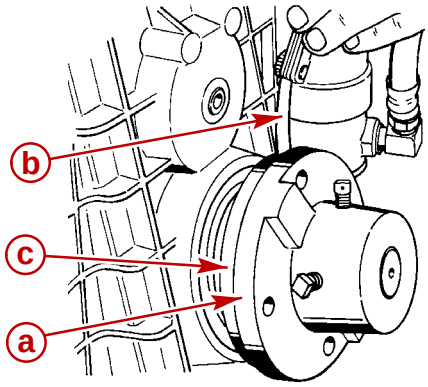
a - Transmission output flange
b - Propeller shaft coupler
c - Propeller shaft
d - Straightedge

4. Check for angular misalignment by holding the coupling faces tightly together and checking for a gap between mating faces with a 0.07 mm (0.003 in.) feeler gauge.
5. Check the gap at 90 degree intervals.

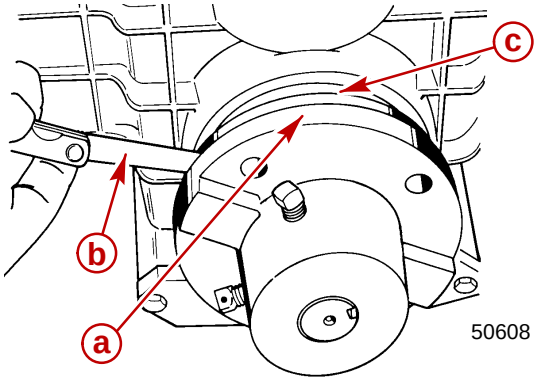


75534

Velvet Drive



50609



50608

ZF/Hurth

a - Propeller shaft coupler
b - Feeler gauge
c - Transmission output flange

6. If the coupling centerlines are not aligned or if the coupling faces are more than 0.08 mm (0.003 in.) out of parallel, adjust the engine mounts.
   a. TO ADJUST THE ENGINE UP OR DOWN, loosen the locking nut on the mounts requiring adjustment and turn the adjusting nuts in the desired direction to raise or lower.

IMPORTANT: The adjusting nuts on either the front mounts or the rear mounts must be turned equally to keep the engine level from side to side.

NOTE: *Some rear mounts have 1 clamping bolt and nut on each side.*

   b. TO MOVE THE ENGINE TO THE LEFT OR THE RIGHT, loosen the clamping bolts and the nuts on all 4 mount brackets and move the engine to the left or the right as necessary to obtain proper alignment. A small amount of adjustment can be obtained with the slot on the front end of some mounts. Loosen the lag bolts (which fasten the mounts to the engine bed) and move the engine, as required. Retighten the lag bolts securely.

IMPORTANT: The large diameter of the mount trunnion MUST NOT extend over 45 mm (1-3/4 in.) from the mount brackets on any of the mounts.

7. After the engine has been properly aligned, secure the engine mounts.
8. Torque the trunnion clamping bolts and the nuts on all 4 mounts.

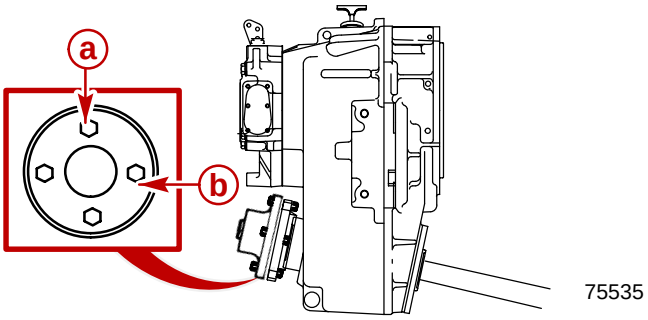
Description	Nm	lb-in.	lb-ft
Trunnion clamping bolt and nut	68		50

9. Tighten the locknut on all 4 mounts.
10. Bend 1 of the tabs on the tab washer down onto the flat of the adjusting nut.

NOTE: *Some rear mounts have 1 clamping screw and nut on each side.*

IMPORTANT: All coupler bolts must be Metric Grade 10.9 (SAE Grade 8) or better, with a shoulder (grip length) sufficient to pass through the mating face plane of the couplers.

11. Secure the coupler together with the bolts, the lockwashers, and the nuts. Torque the bolts.

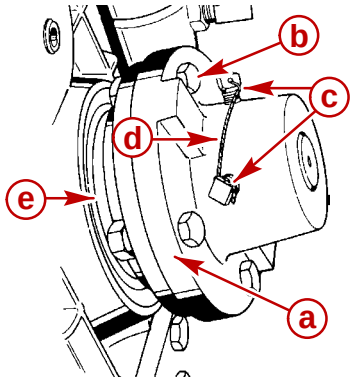


a - Bolts
b - Transmission coupler

Description	Nm	lb-in.	lb-ft
Coupling bolts and nuts	68		50

12. If the propeller shaft coupler has set screws:
    a. Remove the set screws and mark the dimple locations using a transfer punch.
    b. Remove the propeller shaft coupler and drill shallow dimples at the locations marked with the punch.
    c. Install the propeller shaft coupler and torque the bolts. Install the set screws and tighten securely. Safety wire the set screws to ensure that they do not loosen.

50608



a - Propeller shaft coupler
b - Bolts
c - Set screws
d - Safety wire
e - Transmission output flange

Description	Nm	lb-in.	lb-ft
Coupler bolt	68		50

13. Connect the shaft log seal.

Engine Cover Installation

1. Install the flame arrestor and secure with the bracket.
2. Torque the bolts.

Description	Nm	lb-in.	lb-ft
Flame arrestor bolts	12	108	

3. Install the engine cover and tighten the knob securely.

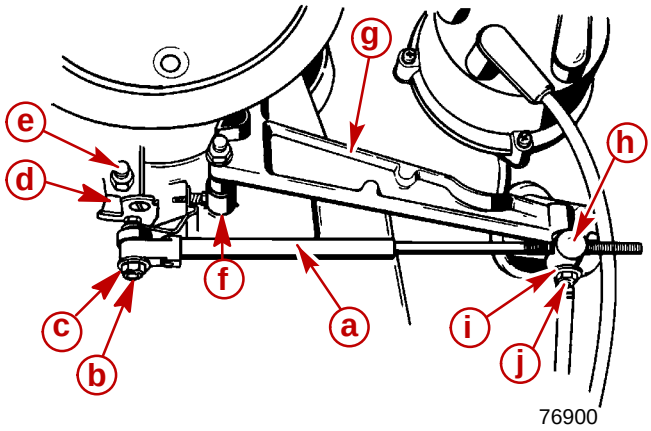
Throttle Cable Installation and Adjustment

Carbureted Models

1. Place remote control handles in NEUTRAL/IDLE position.

IMPORTANT: Route cable to avoid sharp bends and/or contact with moving parts. Do not fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

2. Adjust cable so that it can be placed on both studs simultaneously.
3. Place cable over studs. Do not adjust cable after installation.
4. Secure throttle cable with hardware. Do not overtighten as cable must pivot freely. Tighten until nut contacts, then loosen 1/2 turn.
5. Place remote control throttle lever in the wide open throttle (WOT) position. Ensure that throttle shutters are completely open.
6. Return remote control throttle lever to idle position and ensure that throttle lever contacts idle speed adjustment screw.



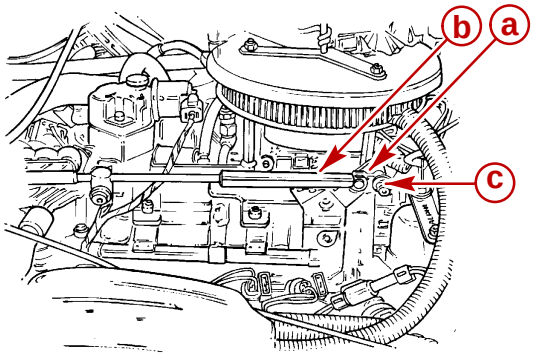
2 BBL V8 models

a - Cable end guide
b - Throttle lever screw
c - Locknut and flat washer (small)
d - Throttle lever
e - Idle speed adjustment screw
f - Idle cam
g - Throttle bracket
h - Cable barrel
i - Flat washer and locknut (large)
j - Throttle cable anchor stud

MPI Models

IMPORTANT: When installing throttle cable, ensure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. Do not fasten any items to throttle cable.

1. Place remote throttle lever in idle position and attach cable to throttle body, following cable manufacturer's instructions.
2. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever.)
3. Adjust barrel on throttle cable to align with hole in anchor plate. Ensure that the hole in barrel positions cable as shown.
4. Tighten locknut until it contacts washer, and then loosen 1/2 turn.



78033

a - Cable end
b - Cable barrel
c - Locknut and flat washer

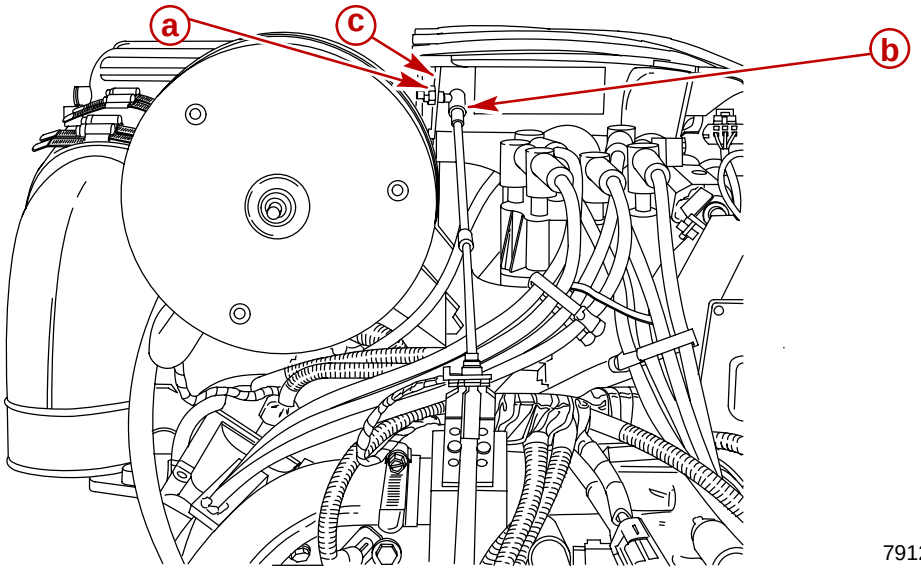
Scorpion Models

IMPORTANT: When installing throttle cable, ensure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. Do not fasten any items to throttle cable.

1. Place remote throttle lever in idle position and attach cable to throttle body, following cable manufacturer's instructions.
2. Screw cable into quick connect until at least 2 threads are engaged.

NOTE: *Can move barrel into different hole of throttle body bracket if necessary for adjustment.*

3. Insert cable into bracket. Bracket can be moved for coarse adjustment.
4. Turn cable barrel for fine tune adjustment.
5. When properly adjusted, hold cable barrel and tighten jam nut securely.



79128

a - Jam nut
b - Cable barrel
c - Throttle body bracket

Shift Cable Installation And Adjustment For Inboard Models

IMPORTANT: When installing shift cables, ensure that cables are routed in such a way as to avoid contact with moving parts and/or sharp bends. All bends must make greater than a 20 cm (8 in.) radius. Do not fasten any items to shift cables.

Shift cable must be connected to the remote control before starting installation and adjustment procedures. Refer to Transmission Propeller Rotation, as previously outlined in the front of this manual, for transmission shift lever direction of movement versus propeller shaft output direction of rotation.

Damage caused to transmission as a result of improper shift lever positioning will not be covered by warranty.

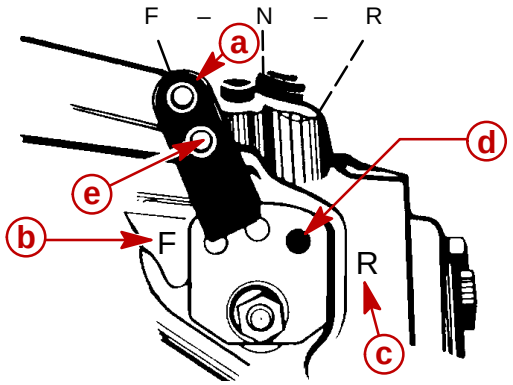
To ensure proper shift and throttle operation, we recommend the use of a Quicksilver remote control and cables. Refer to ***Mercury Precision Parts / Quicksilver Accessories Guide.***

Description	Specification
Shift Cable Travel	70 mm (2-3/4 in.)

Velvet Drive Transmissions

IN-LINE AND REMOTE V-DRIVE

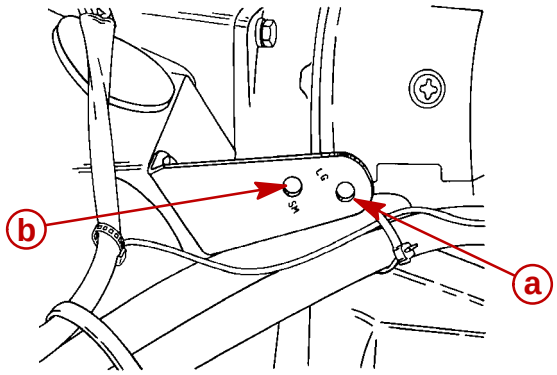
IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner or if remote control and cable do not position shift lever correctly.



22457

- **a** - Transmission shift lever
- **b** - Shift lever MUST BE over this letter in FORWARD
- **c** - Shift lever MUST BE over this letter in REVERSE
- **d** - Poppet ball MUST BE centered in detent hole for each F-N-R position (FORWARD gear shown)
- **e** - Install shift lever stud in this hole, if necessary, to center poppet ball in FORWARD and REVERSE detent holes

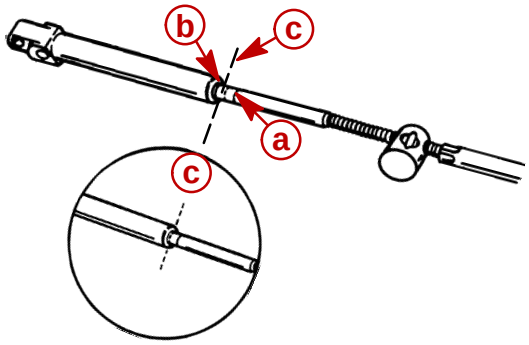
1. Verify shift cable stud is in appropriate stud hole as indicated. Tighten elastic stop nut securely.



50947

a - 71C shift cable anchor stud hole
b - 72C shift cable anchor stud hole

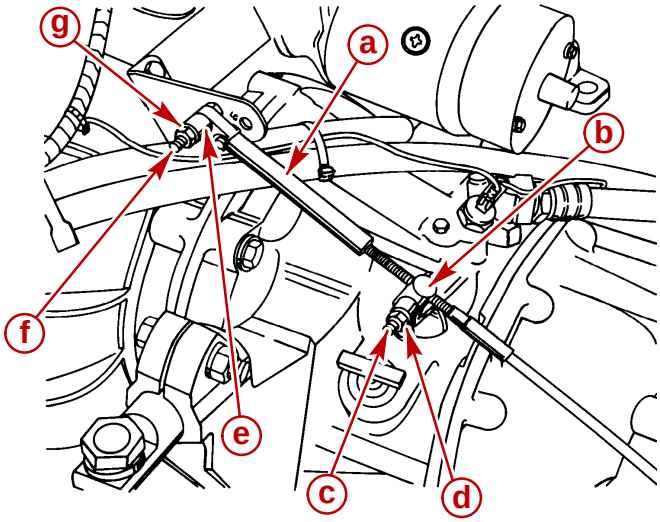
2. Place remote control shift lever and transmission shift lever in NEUTRAL position.
3. Remove nuts and washers from shift cable attaching studs.
4. Locate center of remote control and control shift cable play (backlash), as follows:
   a. Ensure that remote control is in NEUTRAL position.
   b. Push in on control cable end with enough pressure to remove play and mark position "**a**" on tube.
   c. Pull out on control cable end with enough pressure to remove play and mark position "**b**" on tube.
   d. Measure distance between marks "**a**" and "**b**," and mark position "**c**," half-way between marks "**a**" and "**b**."



22024

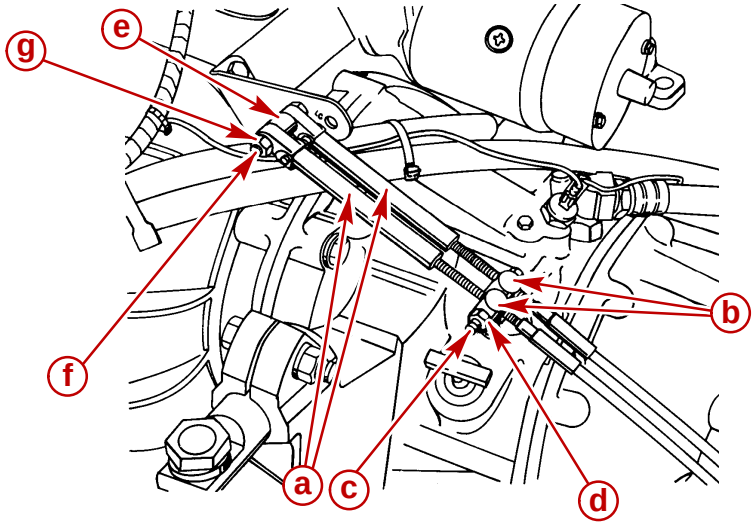
5. Center cable-end play, then adjust cable barrel to align holes in barrel and in cable end guide, with attaching points on transmission.
6. Temporarily install shift cable. Do not secure at this time.
7. Place remote control shift lever in FORWARD gear position and check position of transmission shift lever. Shift lever must be positioned as previously indicated.
8. Place remote control lever in REVERSE gear position and again check shift lever position. Lever must be positioned as previously indicated.

9. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in either gear, move transmission shift lever stud, from top hole in shift lever to bottom hole, and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.
10. Reattach nut and washer to cable end guide stud. Tighten until they contact, then loosen 1/2 turn.
11. Reattach nut and washer to cable barrel stud. Tighten until they contact. Do not overtighten; barrel must rotate.



50947

Rear entry <u>single station</u> installation in-line and remote V-drive

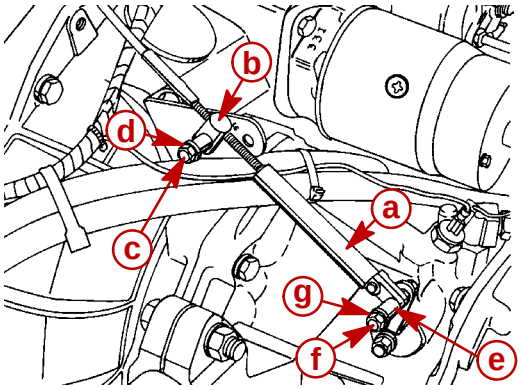


50947

Rear entry <u>dual station</u> installation in-line and V-drive

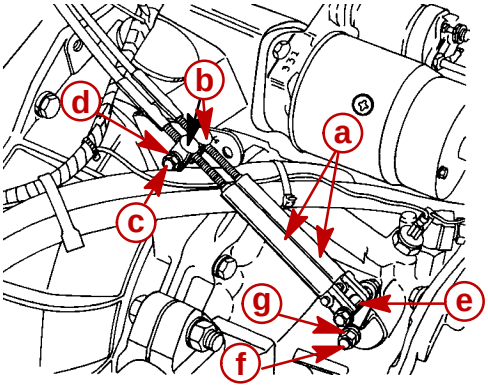
a - Cable end guide
b - Cable barrel
c - Cable barrel stud
d - Elastic stop nut and washer
e - Spacer
f - Cable end guide stud
g - Elastic stop nut and washer

50946



Front entry <u>single station</u> installation in-line and V-drive

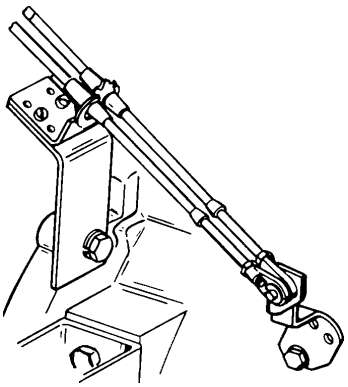
50946



Front entry <u>dual station</u> installation in-line and V-drive

- **a** - Cable end guide
- **b** - Cable barrel
- **c** - Cable barrel stud
- **d** - Elastic stop nut and washer
- **e** - Spacer
- **f** - Cable end guide stud
- **g** - Elastic stop nut and washer

NOTE: *For models equipped with a dual station shift bracket such as the one shown, refer to shift cable manufacturer's instructions for adjusting the cable. Shift lever must be positioned as stated in the preceding steps.*



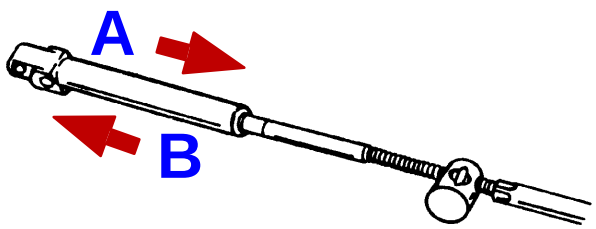
22457

Dual station shift bracket (not Quicksilver)

5000 SERIES (8 DEGREE DOWN ANGLE AND V-DRIVE)

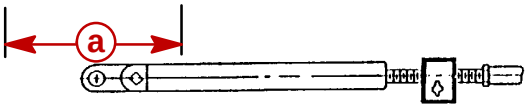
For Left-Hand Propeller Shaft Rotation, shift cable hookup at remote control must result in shift cable end guide moving in direction "**A**" when remote control handle is placed in FORWARD position.

For Right-Hand Propeller Shaft Rotation, shift cable hookup at remote control must result in shift cable end guide moving in direction "**B**" when remote control handle is placed in FORWARD position.



23242

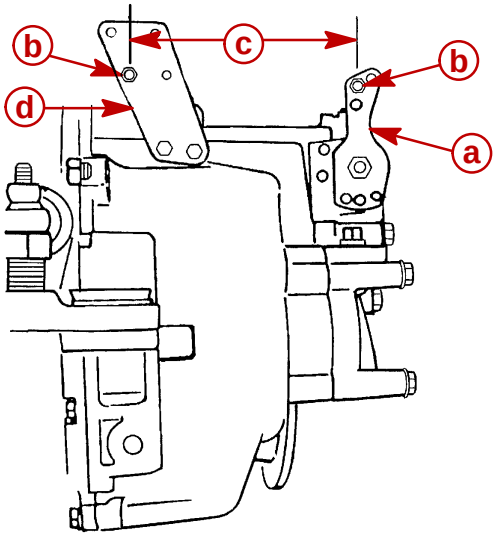
Remote control must provide a total shift cable travel (at transmission end) of at least 70 mm. (2-3/4 in.) This is necessary to position transmission shift lever fully in the FORWARD and REVERSE gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.



72602

a - 70 mm (2-3/4 in.) minimum

IMPORTANT: The distance between studs (Dimension "c") shown in the following illustration is factory set at 18.1 cm (7-1/8 in.).



73284

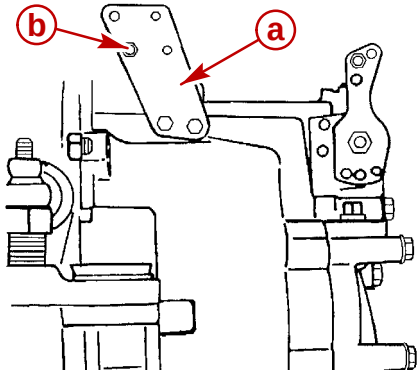
8 degree down-angle shown (V-drive similar)

a - Shift lever
b - Anchor stud
c - Dimension between studs - 18.1 cm (7-1/8 in.)
d - Shift cable bracket

⚠ WARNING

Avoid serious injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole.

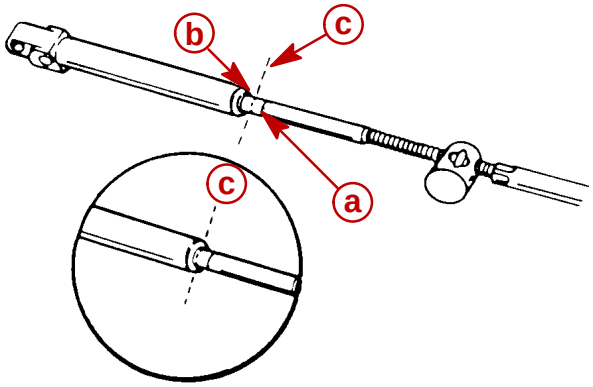
1. Ensure that anchor stud is installed in the front hole as shown in the illustration following.



73284

a - Shift cable bracket
b - Anchor stud in front hole

2. Place remote control shift lever and transmission shift lever in NEUTRAL position.
3. Remove nuts and washers from shift cable attaching studs.
4. Locate center of remote control and control shift cable play (backlash) as follows:
   a. Check that remote control is in NEUTRAL position.
   b. Push in on control cable end with enough pressure to remove play; mark position "**a**" on tube.
   c. Pull out on control cable end with enough effort to remove play; mark position "**b**" on tube.
   d. Measure distance between marks "**a**" and "**b**;" mark position "**c**," half-way between marks "**a**" and "**b**."



72603

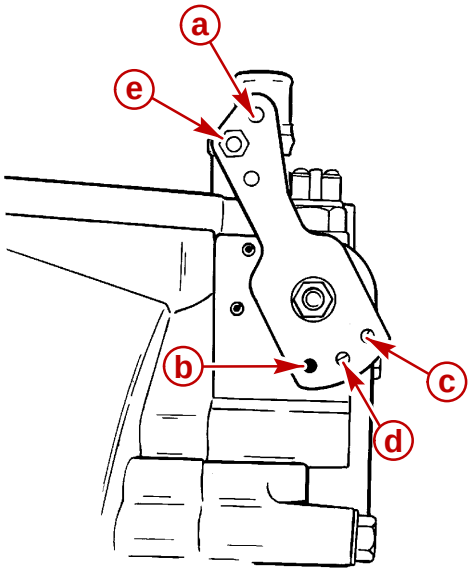
5. Center cable end play, then adjust cable barrel to align holes in barrel and in cable end guide with attaching points on transmission.
6. Temporarily install shift cable. Do not secure at this time.
7. Place remote control shift lever in gear and check position of transmission shift lever. Shift lever must be positioned in the desired detent hole.

IMPORTANT: Transmission is fully in gear when shift lever comes to a stop in either direction.

IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner or if remote control and shift cable do not position shift lever correctly.

⚠ CAUTION

Remote control and shift cable must position transmission shift lever exactly as shown or transmission failure may occur. Do not remove poppet ball or spring.



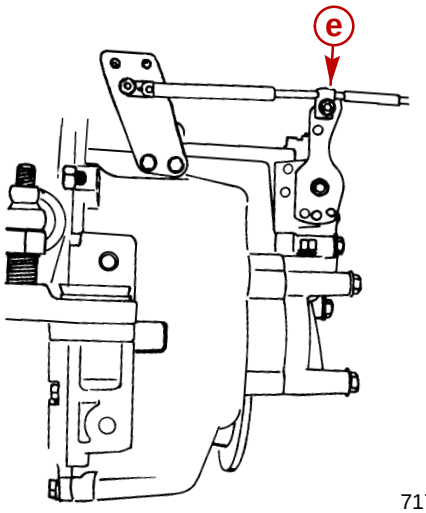
73248

Velvet Drive 5000 series (8 degree down angle shown, V-drive similar)

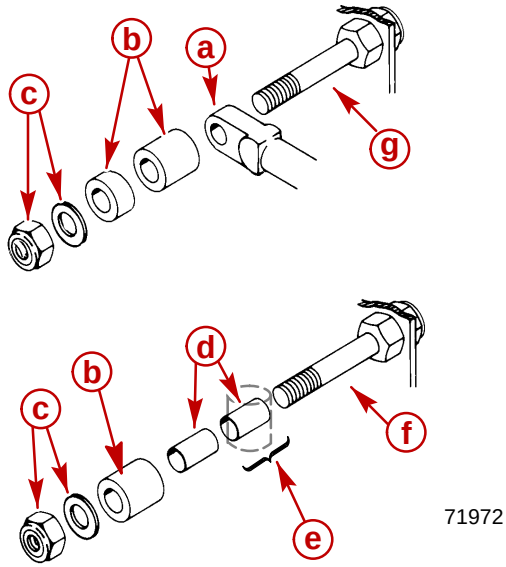
- **a** - Transmission shift lever
- **b** - Poppet ball must be centered in this detent hole when left-hand propeller shaft rotation is desired
- **c** - Poppet ball must be centered in this detent hole when right-hand propeller shaft rotation is desired
- **d** - Poppet ball must be centered in this detent hole for NEUTRAL position
- **e** - Install shift lever stud in this hole when using Quicksilver shift cables

8. Place remote control shift lever in opposite gear position and again check transmission shift lever position. Lever must be positioned in the desired detent hole.
9. If transmission shift lever will not position properly in one gear or both gears, recheck shift cable adjustment and travel. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be repaired or replaced.
10. Install nut and washer to cable end guide stud. Tighten until they contact, then loosen 1/2 turn.

11. Install nut and washer to cable barrel stud. Tighten until they contact. Do not overtighten as barrel must rotate.



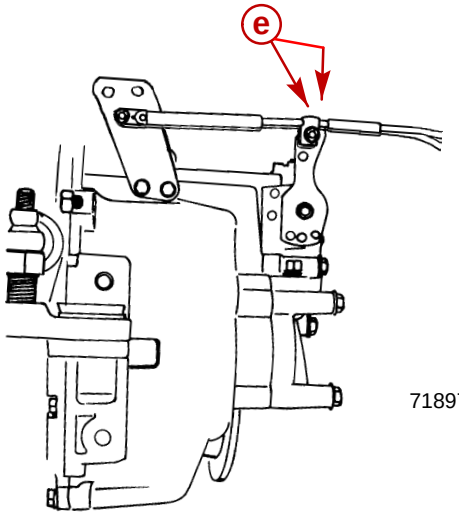
71780



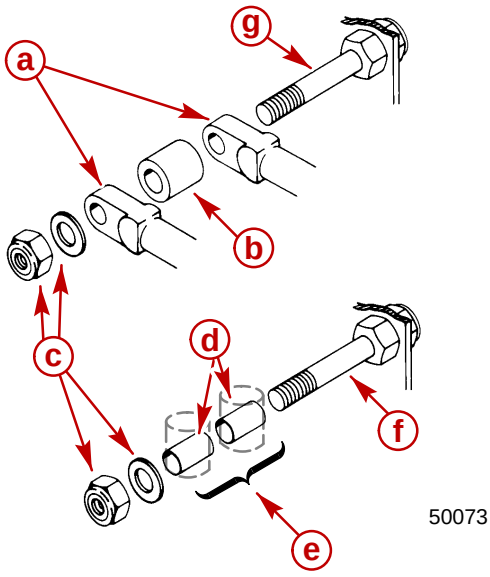
71972

Typical single cable installation - rear approach

- **a** - Cable end guide
- **b** - Spacer (as required)
- **c** - Elastic stop nut and washer
- **d** - Bushings
- **e** - Cable barrel location
- **f** - Cable barrel stud
- **g** - Cable end guide stud



71897



50073

Typical dual cable installation - rear approach

- **a** - Cable end guide
- **b** - Spacer (as required)
- **c** - Elastic stop nut and washer
- **d** - Bushings
- **e** - Cable barrel location
- **f** - Cable barrel stud
- **g** - Cable end guide stud

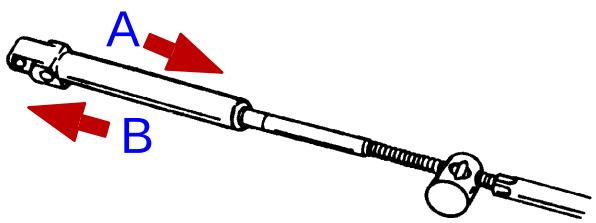
ZF Marine Transmissions

IMPORTANT: These ZF Marine transmissions are full reversing transmissions. Direction of output/propeller rotation is determined by hookup of shift cable at remote control.

Shift cable must be hooked up to remote control before starting installation and adjustment procedures. Refer to **Section 8** for transmission shift lever direction of movement versus propeller shaft output direction of rotation.

For Right-Hand Propeller Rotation – Shift cable hookup at remote control must result in shift cable end guide moving in direction **"A"** when remote control handle is placed in FORWARD position.

For Left-Hand Propeller Rotation – Shift cable hookup at remote control must result in shift cable end guide moving in direction **"B"** when remote control handle is placed in FORWARD position.

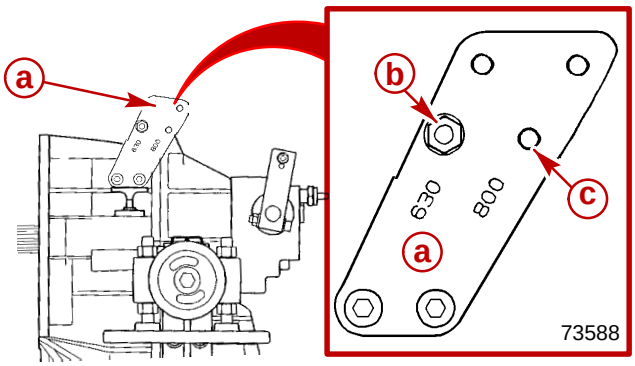


23242

⚠ WARNING

Avoid serious injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole.

1. Ensure that anchor stud is installed in the correct mount hole as shown by the following illustration.



71020

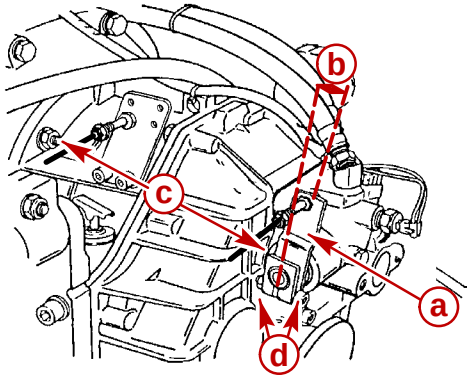
Shift cable bracket - anchor stud positions

- **a** - Cable bracket
- **b** - Quicksilver shift cable anchor stud location - 63A and 63IV
- **c** - Quicksilver shift cable anchor stud location - 80A

IMPORTANT: When installing shift cables, ensure that cables are routed in such a way as to avoid contact with moving parts and/or sharp bends. All bends must make greater than a 20 cm (8 in.) radius. Do not fasten any items to shift cables.

2. Check shift lever positioning as indicated:

IMPORTANT: Check that shift lever is positioned approximately 10 degrees aft of vertical when in the NEUTRAL detent position and that the distance "c" between studs in the following is set at 18.1 cm (7-1/8 in.). If necessary, loosen clamping bolt and position lever so that dimension "c" is as shown when in the NEUTRAL detent position and retighten bolt.

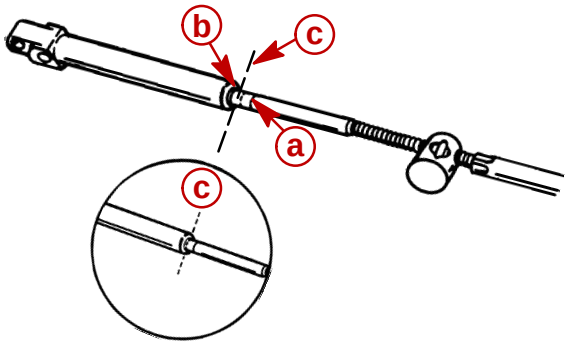


73587

Typical ZF Marine transmission shown

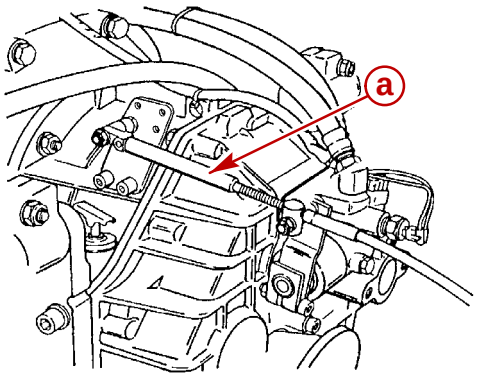
a - Shift lever
b - Lever in neutral detent 10 degrees aft of vertical
c - Dimension between studs - 18.1 cm (7-1/8 in.)
d - Clamping bolt

3. Place remote control shift lever and transmission shift lever in NEUTRAL position.
4. Remove nuts and washers from shift cable attaching studs.
5. Locate center of remote control and control shift cable play (backlash), as follows:
   a. Check that remote control is in NEUTRAL position.
   b. Push in on control cable end with enough pressure to remove play, and mark position "**a**" on tube.
   c. Pull out on control cable end with enough pressure to remove play, and mark position "**b**" on tube.
   d. Measure distance between marks "**a**" and "**b**," and mark position "**c**," half-way between marks "**a**" and "**b**."



22024

6. Center cable-end play, then adjust cable barrel to align holes in barrel, and in cable end guide, with attaching points on transmission.
7. Temporarily install shift cable. Do not secure at this time.



73587

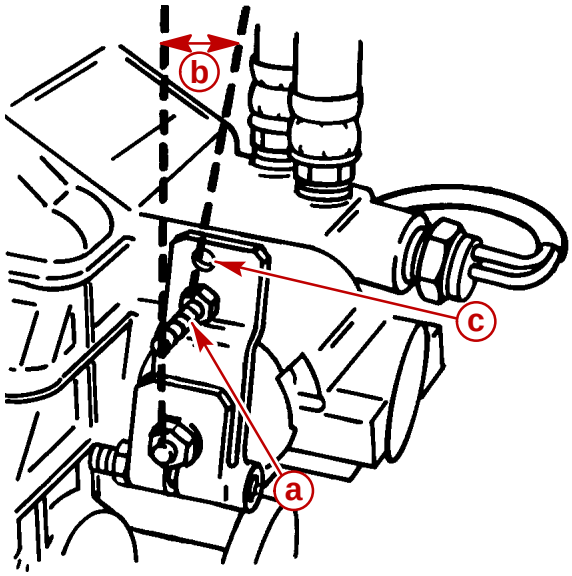
Typical

a - Shift cable end guide

IMPORTANT: Transmission is fully in gear when shift lever comes to a stop in either direction.

8. Place remote control shift lever in FORWARD gear position. Ensure that transmission is fully in gear, as follows:
   a. Hold shift lever in position.
   b. Carefully slide shift cable off of anchor points.
   c. Attempt to move shift lever further.
9. Place remote control shift lever in the REVERSE gear position. Ensure that transmission is fully in gear, following same procedure.

10. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in both gears, move transmission shift lever stud "**a**," from top hole in shift lever, to bottom hole, and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.

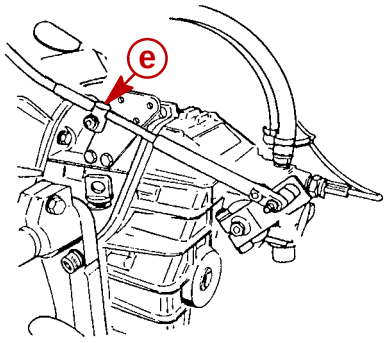


50228

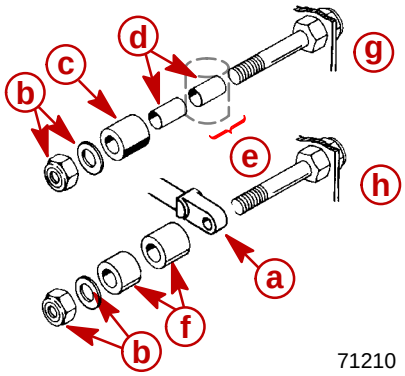
a - Shift lever stud (in bottom hole, if required)
b - Lever in neutral detent 10 degree aft of vertical
c - Shift lever top hole

11. Reattach locknut and washer to cable end guide stud. Tighten until they contact, then loosen 1/2 turn.
12. Reattach locknut and washer to cable barrel stud. Tighten until they contact. Do not overtighten; barrel must rotate.

NOTE: *To change cable approach direction on single or dual station installations, only the spacers/bushings have to be switched to the opposite stud (the studs are identical).*



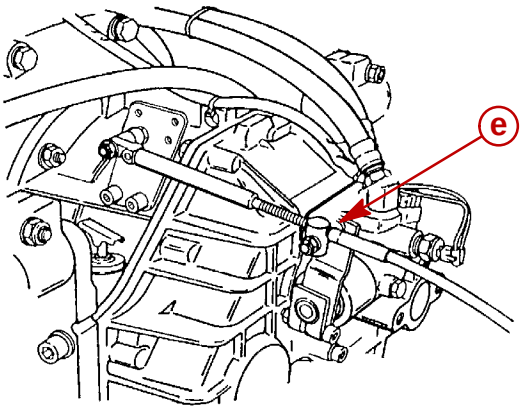
73589



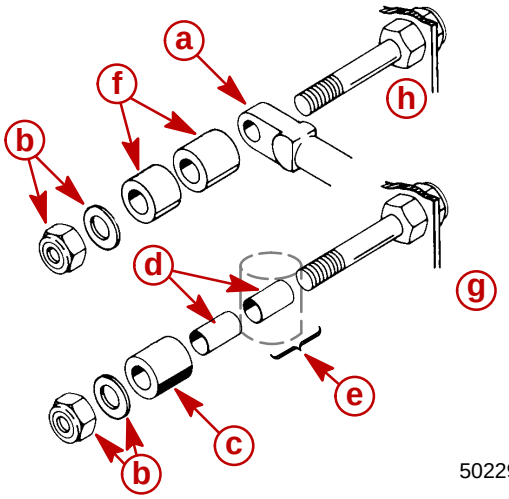
71210

Typical single cable - forward entry

a - Cable end guide
b - Locknut and washer
c - Spacer (fits over bushings)
d - Bushings
e - Cable barrel location
f - Spacer (fits over stud)
g - Cable barrel stud
h - Cable end guide stud



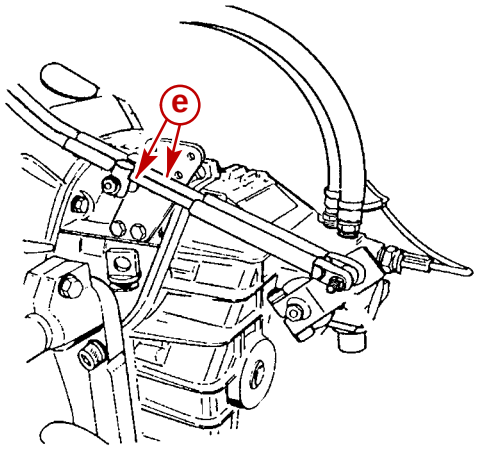
73587



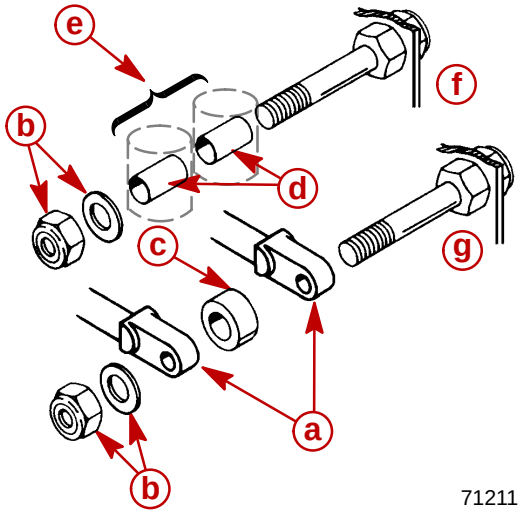
50229

Typical single cable - forward entry

a - Cable end guide
b - Locknut and washer
c - Spacer (fits over bushings)
d - Bushings
e - Cable barrel location
f - Spacer (fits over stud)
g - Cable barrel stud
h - Cable end guide stud



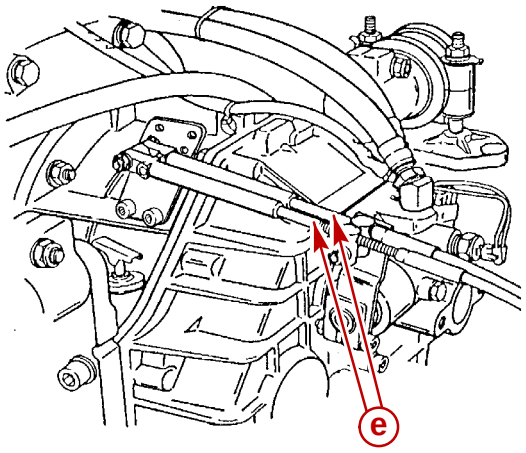
73590



71211

Typical dual cable - forward entry

- **a** - Cable end guides
- **b** - Locknut and washer
- **c** - Spacer (fits over stud)
- **d** - Bushings
- **e** - Cable barrel locations
- **f** - Cable barrel stud
- **g** - Cable end guide stud



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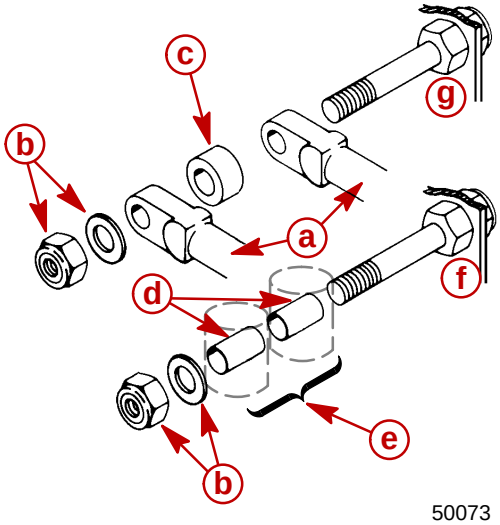


50073

Typical dual cable - rear entry

- **a** - Cable end guides
- **b** - Locknut and washer
- **c** - Spacer (fits over stud)
- **d** - Bushings
- **e** - Cable barrel locations
- **f** - Cable barrel stud
- **g** - Cable end guide stud

Shift Cable Installation And Adjustment for Tow Sports Models

NOTE: *Tow Sports models accommodate single cable forward entry only.*

IMPORTANT: When installing shift cables, ensure that cables are routed in such a way as to avoid contact with moving parts and/or sharp bends. All bends must make greater than a 20 cm (8 in.) radius. Do not fasten any items to shift cables.

Shift cable must be connected to the remote control before starting installation and adjustment procedures. Refer to **Section 8** for transmission shift lever direction of movement versus propeller shaft output direction of rotation.

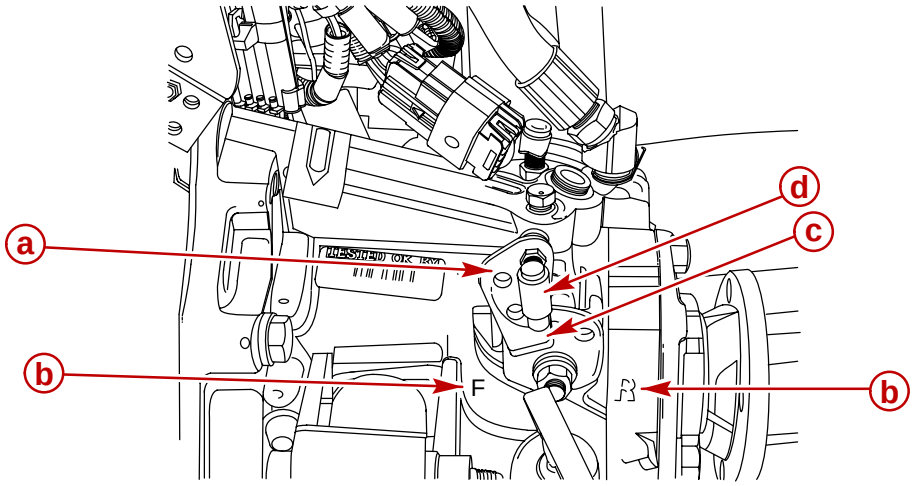
Damage caused to transmission as a result of improper shift lever positioning will not be covered by warranty.

To ensure proper shift and throttle operation, we recommend the use of a Quicksilver remote control and cables. Refer to ***Mercury Precision Parts / Quicksilver Accessories Guide***.

Description	Specification
Shift Cable Travel	70 mm (2-3/4 in.)

Remote control must be set up to retract shift cable when going into FORWARD gear on Velvet Drive 71C In-line transmissions. On Hurth 45C transmission, shift cable actuation must be set up to achieve desired propeller rotation.

IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if remote control and cable do not position shift lever correctly.

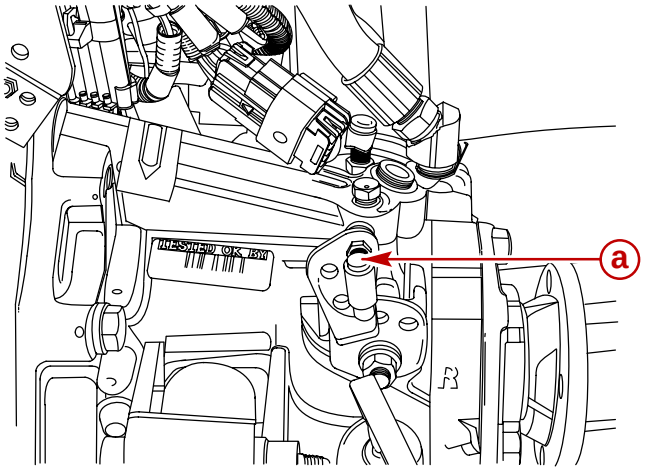


79168

71C In-line shown, other models similar

- **a** - Transmission shift lever
- **b** - Gear designation (NEUTRAL in center)
- **c** - Poppet ball (not visible) MUST BE centered in detent hole for each position (FORWARD gear shown)
- **d** - Shift cable quick connect

1. Verify shift cable stud is in appropriate stud hole as indicated.



79168

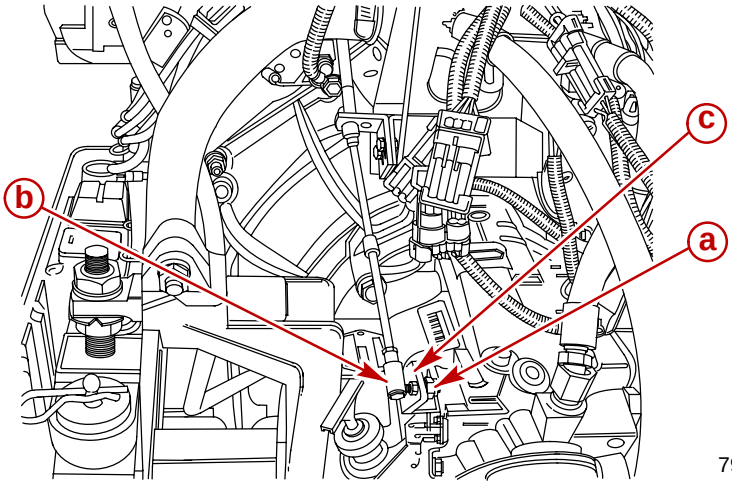
71C In-line shown, other models similar

a - 71C shift cable connection hole

2. Screw cable into quick connect until at least 2 threads are engaged.

NOTE: *Can move barrel into different hole of transmission bracket if necessary for adjustment.*

3. Insert cable into bracket. Bracket can be moved for coarse adjustment.
4. Turn cable barrel for fine tune adjustment.
5. When properly adjusted, hold cable barrel and tighten jam nut securely.

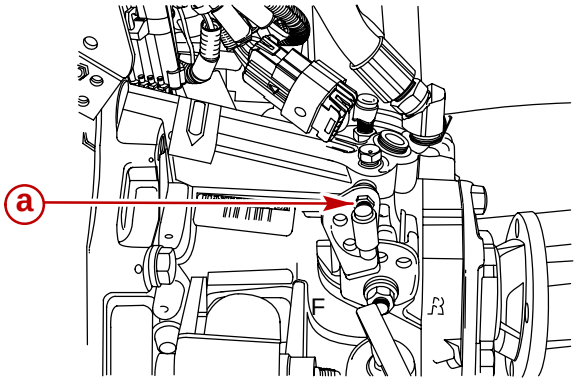


79170

71C In-line shown, others similar

a - Jam nut
b - Cable barrel
c - Bracket

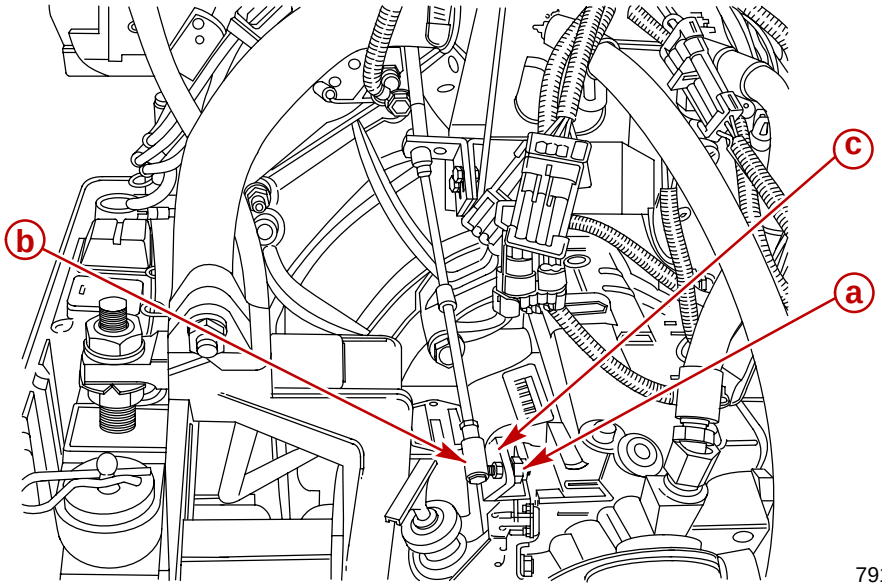
6. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in either gear, move transmission shift lever stud to another hole in the shift lever, and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.



79168

71C In-line shown, other models similar

a - 71C shift cable connection hole



79170

71C In-line shown, others similar

a - Jam nut
b - Cable barrel
c - Bracket

NOTES:

ENGINE MECHANICAL

Section 3A - 5.0 Liter (305 CID), 5.7 Liter (305 CID), 6.2 Liter (305 CID)

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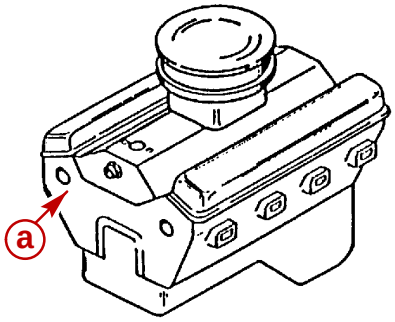
Identification

The Mercury MerCruiser Model can be determined by looking at the last 2 or 3 letters of the engine code stamped into the engine block. This code number is stamped on all Mercury MerCruiser power packages and replacement partial engines, but not replacement engine block assemblies.

If the engine serial number and/or model decals are missing, the engine code letters may help in determining the engine models.



72312

a - Location of engine code

The following is a list of Mercury MerCruiser engines and their respective GM code letters.

Sterndrive (MCM)	**Code**
5.0 liter Alpha and Bravo	2MN
5.7 liter Alpha and Bravo	2MN
5.0 liter MPI Alpha and Bravo	2MN
350 MAG MPI Alpha and Bravo	2MN
350 MAG MPI Alpha and Bravo Horizon	2MN
MX 6.2 MPI	2MNB
MX 6.2 MPI Horizon	2MNB

Inboard (MIE)	**Code**
5.7 liter	2ML
350 MAG MPI Inboard	2ML
350 MAG MPI Horizon Inboard	2ML
MX 6.2 MPI Inboard	2MLB
MX 6.2 MPI Horizon Inboard	2MLB

Tow Sports	**Code**
5.7 liter	2MN
350 MAG MPI	2MN
MX 6.2 MPI	2MN
Black Scorpion	2MN
MX 6.2 Black Scorpion	2MN

General Specifications

5.0 Liter (305 CID)

Description		Specification
Bore		94.89 mm (3.735 in.)
Stroke		88.39 mm (3.480 in.)
Firing order		1-8-4-3-6-5-7-2
Compression ratio		9.4:1
Heads		Cast iron
Block		Cast iron (2 bolt main bearing caps)
Rods		Powder metal
Crankshaft		Cast iron
Pistons		Cast aluminum
Camshaft		Steel
Intake manifold	Carbureted	Cast
Intake manifold upper	MPI	Aluminum
Intake manifold lower	MPI	Cast iron

5.7 Liter (350 CID)

Description		Specification
Bore		101.6 mm (4.00 in.)
Stroke		88.39 mm (3.480 in.)
Firing order		1-8-4-3-6-5-7-2
Compression ratio		9.4:1
Heads		Cast iron
Block		Cast iron (2 bolt main bearing caps)
Rods		Powder metal
Crankshaft		Cast iron
Pistons		Cast aluminum
Camshaft		Steel
Intake manifold	Carbureted	Cast
Intake manifold upper	MPI	Aluminum
Intake manifold lower	MPI	Cast iron
Intake manifold	Scorpion	Cast aluminum

[1] *The 2-bolt main bearing caps are specified, but the 4-bolt main bearing caps are acceptable.*

General Specifications (continued)

6.2 Liter (377 CID)

Description		Specification
Bore		101.6 mm (4.00 in.)
Stroke		95.25 mm (3.750 in.)
Firing order		1-8-4-3-6-5-7-2
Compression ratio		9.0:1
Heads		Cast iron
Block		Cast iron (2 bolt main bearing caps)
Rods		Powder metal
Crankshaft		Forged steel
Pistons		Cast aluminum
Camshaft		Steel billet (5150)
Intake manifold upper	MPI	Aluminum
Intake manifold lower	MPI	Cast iron
Intake manifold	Scorpion	Cast aluminum

Engine Specifications - 5.0 Liter (305 CID) And 5.7 Liter (350 CID)

Cylinder Head

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Surface flatness	At exhaust manifold deck	0.05 mm (0.0020 in.)	
	At engine block deck - within an 152 mm (6.0 in.) area	0.10 mm (0.0039 in.)	
	At intake manifold deck	0.10 mm (0.0039 in.)	

Cylinder Bore

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Diameter		94.894-94.947 mm (3.7360-3.7381 in.)	101.618-101.643 mm (4.0007-4.0017 in.)
Out of round	Production	0.025 mm (0.0010 in.) maximum	
	Service	0.05 mm (0.0020 in.) maximum	
Taper	Production - thrust side	0.012 mm (0.0005 in.) maximum	
	Production - relief side	0.025 mm (0.0010 in.) maximum	
	Service limit	0.025 mm (0.0010 in.) over production	

Oil Pump

Description	5.0 liter (305 CID)	5.7 liter (350 CID)
Oil pump dowel pin height	6.4 mm (0.2520 in.)	

Piston Bore Clearance

Description	5.0 liter (305 CID)	5.7 liter (350 CID)
Production	0.018-0.061 mm (0.0007-0.0024 in.)	0.018-0.053 mm (0.0007-0.0020 in.)
Service	0.018-0.068 mm (0.0007-0.0026 in.)	0.018-0.061 mm (0.0007-0.0024 in.)

Engine Specifications - 5.0 Liter (305 CID) And 5.7 Liter (350 CID) (continued)

Piston Rings

TOP COMPRESSION

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Groove clearance	Production	0.030-0.070 mm (0.0012-0.0028 in.)	
	Service	0.030-0.090 mm (0.0012-0.0035 in.)	
Gap	Production	0.25-0.51 mm (0.0098-0.0201 in.)	0.25-0.40 mm (0.0098-0.0157 in.)
	Service	0.25-0.65 mm (0.0098-0.0259 in.)	0.25-0.50 mm (0.0098-0.0197 in.)

SECOND COMPRESSION

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Groove clearance	Production	0.030-0.074 mm (0.0012-0.0029 in.)	0.038-0.080 mm (0.0015-0.0031 in.)
	Service	0.030-0.090 mm (0.0012-0.0035 in.)	0.040-0.100 mm (0.0016-0.0039 in.)
Gap	Production	0.46-0.66 mm (0.0181-0.0298 in.)	0.038-0.058 mm (0.0015-0.0023 in.)
	Service	0.46-0.90 mm (0.0181-0.0354 in.)	0.46-0.80 mm (0.0181-0.0315 in.)

OIL CONTROL

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Groove clearance	Production	0.051-0.203 mm (0.0020-0.0080 in.)	0.046-0.096 mm (0.0018-0.0038 in.)
	Service	0.051-0.22 mm (0.0020-0.0009 in.)	0.046-0.100 mm (0.0018-0.0039 in.)
Gap	Production	0.25-0.76 mm (0.0098-0.0299 in.)	
	Service	0.25-0.89 mm (0.0098-0.0350 in.)	0.25-0.90 mm (0.0098-0.0354 in.)

Piston Pin

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Diameter		23.545-23.548 mm (0.9270-0.9271 in.)	
Clearance	Production	0.010-0.020 mm (0.0004-0.0008 in.)	0.013-0.023 mm (0.0005-0.0009 in.)
	Service limit	0.013-0.025 mm (0.0005-0.0010 in.)	
Fit in connecting rod		0.012-0.050 mm (0.0005-0.0020 in.) interference	

Engine Specifications - 5.0 Liter (305 CID) And 5.7 Liter (350 CID) (continued)

Crankshaft

MAIN BEARING JOURNAL

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Diameter	Number 1	62.189-62.212 mm (2.4484-2.4493 in.)	
	Number 2, 3, 4	62.181-62.207 mm (2.4481-2.4491 in.)	
	Number 5	62.185-62.207 mm (2.4482-2.4491 in.)	
Taper	Production	0.005 mm (0.0002 in.) maximum	
	Service	0.025 mm (0.0010 in.) maximum	
Out of round	Production	0.005 mm (0.0002 in.) maximum	
	Service	0.025 mm (0.0010 in.) maximum	

MAIN BEARING CLEARANCE

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Production	Number 1	0.018-0.053 mm (0.0007-0.0021 in.)	
	Number 2, 3, 4	0.030-0.068 mm (0.0012-0.0027 in.)	
	Number 5	0.020-0.060 mm (0.0008-0.0024 in.)	
Service	Number 1	0.025-0.051 mm (0.0010-0.0020 in.)	
	Number 2, 3, 4	0.025-0.064 mm (0.0010-0.0025 in.)	
	Number 5	0.038-0.063 mm (0.0015-0.0025 in.)	

CONNECTING ROD JOURNAL

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Diameter		56.505 - 56.533 mm (2.2246-2.2257 in.)	
Taper	Production	0.007 mm (0.0003 in.) maximum	
	Service	0.025 mm (0.0010 in.) maximum	
Out of round	Production	0.007 mm (0.0003 in.) maximum	
	Service	0.025 mm (0.0010 in.) maximum	

MISCELLANEOUS

Description	5.0 liter (305 CID)	5.7 liter (350 CID)
Runout	0.038 mm (0.0015 in.)	
End play (thrust clearance)	0.05-0.20 mm (0.0020-0.0079 in.)	

Engine Specifications - 5.0 Liter (305 CID) And 5.7 Liter (350 CID) (continued)

Connecting Rod

CONNECTING ROD BEARING

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Clearance	Production	0.033-0.078 mm (0.0013-0.0031 in.)	
	Service limit	0.025-0.063 mm (0.0010-0.0025 in.)	
Rod side clearance		0.15-0.61 mm (0.0059-0.0240 in.)	

Valve

CLEARANCE (LASH)

Description	5.0 liter (305 CID)	5.7 liter (350 CID)
Intake and exhaust	Rotate the valve rocker arm nut clockwise 360 degrees (1 turn) from zero clearance	

LIFTER

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Type		Hydraulic roller	
Rocker arm ratio		1.50 : 1	
Valve lift	Intake	6.97-7.07 mm (0.2744-0.2783 in.)	
	Exhaust	7.20-7.30 mm (0.2834-2874 in.)	

HEAD AND STEM

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Valve diameter	Intake	46.74 mm (1.84 in.)	49.28 mm (1.94 in.)
	Exhaust	38.1 mm (1.5000 in.)	
Face angle	Intake	45 degrees	
	Exhaust		
Margin after surfacing	Intake	0.79 mm (0.0311 in.) minimum	
	Exhaust	1.524-2.032 mm (0.0600-0.0800 in.)	
Stem diameter	Intake	8.661-8.679 mm (0.3410-0.3417 in.)	
	Exhaust		
Service stem oversize diameter	Exhaust only	+ 0.774 mm (+0.0305 in.)	
Valve stem oil seal	Installed height[1]	1-2 mm (0.0394-0.0787 in.)	

[1] *Measured from the top of the valve guide boss to the bottom of the valve stem oil seal.*

Engine Specifications - 5.0 Liter (305 CID) And 5.7 Liter (350 CID) (continued)

STEM CLEARANCE

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Production	Intake	0.025-0.069 mm (0.0010-0.0027 in.)	
	Exhaust	0.025-0.069 mm (0.0010-0.0027 in.)	
Service	Intake	0.025-0.094 mm (0.0010-0.0037 in.)	
	Exhaust	0.025-0.094 mm (0.0010-0.0037 in.)	

Valve

SEAT

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Seat angle	Intake and exhaust	46 degrees	
Top correction cut angle		30 degrees	
Bottom correction cut angle		60 degrees	
Width	Intake	1.14-1.78 mm (0.0449-0.0701 in.)	1.02-1.65 mm (0.0402-0.0650 in.)
	Exhaust	1.65-2.49 mm (0.0650-0.0980 in.)	1.50-2.56 mm (0.0591-0.1008 in.)
Runout	Intake and exhaust	0.05 mm (0.0020 in.) maximum	

SPRING

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Free length		51.3 mm (2.02 in.)	
Pressure	Valve closed	338-374 N at 43.2 mm (76-84 lb) at (1.7008 in.)	
	Valve open	832-903 N at 32.3 mm (187-203 lb) at (1.2717 in.)	
Installed height	Intake	42.92-43.43 mm (1.6898-1.7098 in.)	
	Exhaust		
Approximate number of coils		4	

Engine Specifications - 5.0 Liter (305 CID) And 5.7 Liter (350 CID) (continued)

Camshaft

Description	5.0 liter (305 CID)	5.7 liter (350 CID)
Journal diameter	47.440-47.490 mm (1.8677-1.8697 in.)	
Journal out of round	0.025 mm (0.0010 in.) maximum	
Camshaft runout	0.065 mm (0.0026 in.) maximum	

Timing Chain

Description	5.0 liter (305 CID)	5.7 liter (350 CID)
Chain deflection	11 mm (0.4331 in.) maximum	

Flywheel

Description	5.0 liter (305 CID)	5.7 liter (350 CID)
Runout	0.203 mm (0.0080 in.) maximum	

Engine Specifications - 6.2 Liter (377 CID)

Cylinder Head

Description		6.2 liter (377 CID)
Surface flatness	At exhaust manifold deck	0.05 mm (0.0020 in.)
	At engine block deck - within an 152 mm (6.0 in.) area	0.10 mm (0.0039 in.)
	At intake manifold deck	0.10 mm (0.0039 in.)

Cylinder Bore

Description		6.2 liter (377 CID)
Diameter		101.618-101.643 mm (4.0007-4.0017 in.)
Out of round	Production	0.025 mm (0.0010 in.) maximum
	Service	0.05 mm (0.0020 in.) maximum
Taper	Production - thrust side	0.012 mm (0.0005 in.) maximum
	Production - relief side	0.025 mm (0.0010 in.) maximum
	Service limit	0.025 mm (0.0010 in.) over production

Oil Pump

Description	6.2 liter (377 CID)
Oil pump dowel pin height	6.4 mm (0.2520 in.)

Piston Clearance

Description	6.2 liter (377 CID)
Production	0.018-0.053 mm (0.0007-0.0021 in.)
Service	0.018-0.068 mm (0.0007-0.0027 in.)

Engine Specifications - 6.2 Liter (377 CID) (continued)

Piston Rings

TOP COMPRESSION

Description		6.2 liter (377 CID)
Groove clearance	Production	0.030-0.070 mm (0.0012-0.0027 in.)
	Service	0.030-0.090 mm (0.0012-0.0035 in.)
Gap	Production	0.25-0.51 mm (0.0098-0.0201 in.)
	Service	0.30-0.68 mm (0.01118-0.0268 in.)

SECOND COMPRESSION

Description		6.2 liter (377 CID)
Groove clearance	Production	0.040-0.080 mm (0.0015-0.0030 in.)
	Service	0.040-0.100 mm (0.0015-0.0040 in.)
Gap	Production	0.46-0.66 mm (0.0181-0.0260 in.)
	Service	0.51-0.94 mm (0.0201-0.0370 in.)

OIL CONTROL

Description		6.2 liter (377 CID)
Groove clearance	Production	0.051-0.17 mm (0.0020-0.0067 in.)
	Service	0.051-0.195 mm (0.0020-0.0076 in.)
Gap	Production	0.25-0.76 mm (0.0098-0.0299 in.)
	Service limit	0.28-0.81 mm (0.0110-0.0319 in.)

Piston Pin

Description		6.2 liter (377 CID)
Diameter		23.545-23.548 mm (0.9269-0.9270 in.)
Clearance	Production	0.013-0.023 mm (0.0005-0.0009 in.)
	Service limit	0.013-0.025 mm (0.0005-0.0010 in.) maximum
Fit in rod		0.021-0.040 mm (0.0008-0.0016 in.) interference

Engine Specifications - 6.2 Liter (377 CID) (continued)

Crankshaft

MAIN BEARING JOURNAL

Description		6.2 liter (377 CID)
Diameter	Number 1	62.189-62.212 mm (2.4484-2.4493 in.)
	Number 2, 3, 4	62.181-62.207 mm (2.4481-2.4491 in.)
	Number 5	62.177-62.207 mm (2.4479-2.4491 in.)
Taper	Production	0.005 mm (0.0002 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum
Out of round	Production	0.005 mm (0.0002 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum

MAIN BEARING CLEARANCE

Description		6.2 liter (377 CID)
Production	Number 1	0.018-0.053 mm (0.0007-0.0021 in.)
	Number 2, 3, 4	0.022-0.061 mm (0.0009-0.0024 in.)
	Number 5	0.025-0.069 mm (0.0010-0.0027 in.)
Service	Number 1	0.025-0.051 mm (0.0010-0.0020 in.)
	Number 2, 3, 4	0.025-0.064 mm (0.0010-0.0025 in.)
	Number 5	0.038-0.076 mm (0.0015-0.0030 in.)

CONNECTING ROD JOURNAL

Description		6.2 liter (377 CID)
Diameter		53.284-53.334 mm (2.0978-2.0998 in.)
Taper	Production	0.007 mm (0.0003 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum
Out of round	Production	0.007 mm (0.0003 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum

MISCELLANEOUS

Description	6.2 liter (377 CID)
Runout	0.05-0.20 mm (0.0020-0.0079 in.)
End play (thrust clearance)	0.05-0.20 mm (0.0020-0.0079 in.)

Engine Specifications - 6.2 Liter (377 CID) (continued)

Connecting Rod

CONNECTING ROD BORE (CRANKSHAFT END)

Description		6.2 liter (377 CID)
Diameter		53.284-53.334 mm (2.0977-2.0997 in.)
Taper	Production	0.025 mm (0.0010 in.)
	Service limit	
Out of round	Production	0.025 mm (0.0010 in.)
	Service limit	

CONNECTING ROD BEARING

Description		6.2 liter (377 CID)
Clearance	Production	0.033-0.088 mm (0.0013-0.0035 in.)
	Service	0.025-0.076 mm (0.0010-0.0030 in.)
Rod side clearance		0.15-0.61 mm (0.0059-0.0240 in.)

Valve

CLEARANCE (LASH)

Description	6.2 liter (377 CID)
Intake and exhaust	Rotate the valve rocker arm nut clockwise 360 degrees (1 turn) from zero clearance

LIFTER

Description		6.2 liter (377 CID)
Type		Hydraulic roller
Rocker arm ratio		1.50 : 1
Valve lift	Intake	7.90-8.00 mm (0.3114-0.3153 in.)
	Exhaust	8.00-8.10 mm (0.3160-3200 in.)

Engine Specifications - 6.2 Liter (377 CID) (continued)

Valve (continued)

HEAD AND STEM

Description		6.2 liter (377 CID)
Valve diameter	Intake	49.28 mm (1.94 in.)
	Exhaust	38.1 mm (1.50 in.)
Face angle	Intake	45 degrees
	Exhaust	45 degrees
Margin after surfacing	Intake	0.79 mm (0.031 in.) minimum
	Exhaust	1.524-2.032 mm (0.0600-0.0800 in.)
Stem diameter	Intake	8.66 mm (0.341 in.)
	Exhaust	8.66 mm (0.341 in.)
service stem oversize diameter	Exhaust only	+ 0.0774 mm (+ 0.0305 in.)
Valve stem oil seal	Installed height[1]	1-2 mm (0.0394-0.0787 in.)

[1] *Measured from the top of the valve guide boss to the bottom of the valve stem oil seal.*

STEM CLEARANCE

Description		6.2 liter (377 CID)
Production	Intake	0.025-0.069 mm (0.0010-0.0027 in.)
	Exhaust	0.025-0.069 mm (0.0010-0.0027 in.)
Service	Intake	0.025-0.094 mm (0.0010-0.0037 in.)
	Exhaust	0.025-0.194 mm (0.0010-0.0076 in.)

SEAT

Description		6.2 liter (377 CID)
Seat angle	Intake and exhaust	46 degrees
Top correction cut angle		30 degrees
Bottom correction cut angle		60 degrees
Width	Intake	1.02-1.65 mm (0.0434-0.0650 in.)
	Exhaust	1.50-2.56 mm (0.0591-0.1008 in.)
Runout	Intake	0.05 mm (0.0020 in.) maximum
	Exhaust	

Engine Specifications - 6.2 Liter (377 CID) (continued)

Valve (continued)

SPRING

Description		6.2 liter (377 CID)
Free length		51.3 mm (2.0197 in.)
Pressure	Valve closed	338-374 N at 43.2 mm (76-84 lb at 1.7008 in.)
	Valve open	832-903 N at 32.3 mm (187-203 lb at 1.2717 in.)
Installed height	Intake	42.92-43.43 mm (1.6898-1.7098 in.)
	Exhaust	42.92-43.43 mm (1.6898-1.7098 in.)
Approximate number of coils		4

Camshaft

Description	6.2 liter (377 CID)
Journal diameter	47.440-47.490 mm (1.8677-1.8697 in.)
Journal out of round	0.025 mm (0.0010 in.) maximum
Camshaft runout	0.065 mm (0.0026 in.) maximum

Timing Chain

Description	6.2 liter (377 CID)
Chain deflection	11 mm (0.4331 in.) maximum

Flywheel

Description	6.2 liter (377 CID)
Runout	0.203 mm (0.0080 in.) maximum

Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Loctite 242 Threadlocker	Camshaft rear bearing hole expansion plug	92-809821
	Camshaft thrust plate retainer bolt	
	Engine block core hole expansion plug	
	Exhaust manifold bolt	
	Fuel rail bolt	
	Intake manifold bolt	
	Throttle body stud	
	Upper intake manifold stud	
Loctite 5900 Ultra-Black RTV Silicone Sealant	Crankshaft balancer keyway	92-809826
	Engine block to the crankshaft rear oil seal housing junction at the oil pan sealing surfaces	
	Engine block to the engine front cover junction at the oil pan sealing surfaces	
	Engine block at the lower intake manifold sealing surfaces	
	Block to intake manifold	
	Front cover seal retainer-to-seal mating surface	

Lubricants / Sealants / Adhesives (continued)

Description	Where Used	Part Number
Loctite 565 PST	Cylinder head bolts	Obtain locally
	Engine block coolant drain hole plug	
	Engine block oil gallery plug	
	Engine Coolant Temperature (ECT) sensor	
	Expansion cup plug (camshaft rear bearing hole)	
	Expansion cup plug (engine block core hole)	
	Knock sensor	
	Oil dipstick tube	
	Oil pressure sender	
	Oil gallery plugs	
	Oil pressure switch	
	Oil pressure switch fitting	
	Oil pickup screen pipe to oil pump body	
	Water circulating pump bolt	
Engine Oil	On all moving parts during assembly as indicated	Obtain locally
80W Gear Lube	Rocker arm stud	Obtain locally
Johnson Engine Prelube	Lifters, camshafts and camshafts lobes	92-801779
	Valve pushrod surface, rocker arm and rocker arm ball contact surfaces	
Needle Bearing Assembly Lubricant	Valve stem locks	92-802868A1
Perfect Seal	Water passages on engine block	92-34227-1

Tools

Kent-Moore Tools 29784 Little Mack Roseville, MI 48066 Phone: (313) 574-2332 (800) 345-2233	
Description	**Part Number**
Valve Spring Compressor (Cylinder Head On Engine)	J5892-D
Valve Lifter	J8062
Valve Spring Tester	J9666
Valve Guide Cleaner	J8101
Valve Guide Reamer (Standard)	J7049
Valve Guide Reamer (0.015 In. Oversize)	J5830-02
Valve Stem Seal Installer	J42073
Rocker Arm Stud Remover	J5802-01
Rocker Arm Stud Installer	J6880
Rocker Stud Hole Reamer (0.003 in. oversize)	J5715
Rocker Stud Hole Reamer (0.013 in. oversize)	J6036
Carbon Cleaning Brush	J8089
Piston Pin Tool	J24086-C
Piston Ring Groove Cleaner	J3936-03
Piston Ring Compressor	J8037
Connecting Rod Guide Tool (3/8 -24)	J5239
Oil Pump Suction Pipe Installer	J21882
Camshaft Bearing Installer/Remover Tool	J6098-10
Mounting Stud Adapter	J8520-1
Crankshaft Balancer Remover And Installer	J23523-F
Cover Aligner / Seal Installer	J35468
Crankshaft Gear Remover	J5825-A
Rear Pinion Bearing Race Installer	J5590
Spark Plug Port Adapter	J23590
Main Bearing Remover And Installer	J8080
Rear Main Seal Installer	J35621-B
Fuel Line Disconnect Tool	J44581
Cylinder Bore Ridge Reamer	J24270
Ball Socket Adapter Tool	J8520-1
Cylinder Hone Kit	J5902-01

Precautions

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

⚠ WARNING

BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Ensure that ignition key is OFF and do not smoke or allow sources of spark and/or open flames in the area.

⚠ CAUTION

If boat is in the water, seacock must remain closed until engine is to be re-started to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning: Open seacock or reconnect water inlet hose before starting engine.

⚠ CAUTION

Compressed air could cause injury. Always wear safety glasses while using compressed air.

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

⚠ CAUTION

Do not operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.

IMPORTANT: To provide the initial lubrication during first starting, lubricate all engine moving-parts during assembly with clean engine oil, unless otherwise specified.

Torque Specifications

Description		Nm	lb-in.	lb-ft
Alternator brace to alternator bolt		28		21
Alternator brace to engine bolt		41		30
Alternator to mounting bracket bolt		48		35
By-pass valve block adapter bolt		27		20
Alternator mounting bracket bolt		41		30
Camshaft position sensor bolt		9	80	
Camshaft thrust plate retainer bolt		12	106	
Camshaft sprocket bolt		25		18
Connecting rod nut - 5.0 liter (305 CID) and 5.7 liter (350 CID)				
	First pass	27		20
	Final pass (angle torque)	+ 70 degrees		
Connecting rod nut - 6.2 liter (377 CID)				
	First pass	27		20
	Final pass (angle torque)	+ 45 degrees		
Coolant drain hole plug				
	Left front	60		44
	Sides	20		15
Coupler to flywheel bolts (MCM)		48		35
Crankshaft main bearing cap bolt and stud - preferred method				
2 bolt type cap	First pass	20		15
	Final pass	+ 73 degrees		
4 bolt type cap	First pass - inboard and outboard bolts and studs	20		15
	Final pass - outboard bolt	+ 43 degrees		
	Final pass - inboard bolt and stud	+ 73 degrees		
Crankshaft main bearing cap bolt and stud - optional method				
2 bolt type cap	One pass - all bolts evenly tightened	105		77
4 bolt type cap	One pass - all inboard bolts evenly tightened	105		77
	One pass - all outboard bolts evenly tightened	90		66

Torque Specifications (continued)

Description			Nm	lb-in.	lb-ft
Crankshaft balancer (torsional damper) bolt			95		70
Crankshaft oil deflector nut			41		30
Crankshaft position sensor bolt			9	80	
Crankshaft pulley bolt			58		43
Cylinder head bolt - preferred method					
All bolts in sequence	First pass		30		22
In sequence angle torque	Final pass	Long bolts	+ 75 degrees		
		Medium bolts	+ 65 degrees		
		Short bolts	+ 55 degrees		
Cylinder head bolt - optional method					
All bolts in sequence	First pass		35		26
	Second pass		60		44
	Final pass		90		66
Distributor cap bolt			2.4	21	
Distributor hold down clamp bolt			25		18
Drive plate to flywheel bolts (MIE)			48		35
Exhaust manifold cap screws			27		20
Engine flywheel bolt			100		74
Engine coolant temperature (ECT) sensor			20		15
Engine block coolant drain hole plug			20		15
Block adapter fitting / bushing			31		23
Flywheel housing studs and bolts			41		30
Flywheel housing cover			9	80	
Front cover bolt			12	106	
Front mount bracket			41		30

Torque Specifications (continued)

Description		Nm	lb-in.	lb-ft
Fuel rail bracket bolt		6	53	
Fuel rail retainer nut		3	27	
Ignition coil bolt		12	106	
Intake manifold bolt				
All bolts in sequence	First pass	3	27	
	Second pass	12	106	
	Final pass	15	132	
Knock sensor		20		15
MAPT sensor bolt		12	106	
Oil deflector nut		41		30
Oil filter adapter (5/16 in.-18)		27		20
Oil filter adapter bolt		25		18
Oil gallery plug		20		15
Oil lines		27		20
Oil pan bolt or nut		12	106	
Oil pan stud (front)		6	53	
Oil pan stud nut		25		18
Oil pan fitting hollow bolt		20		15
Oil pan drain plug		25		18
Oil pressure switch fitting		15	132	
Oil pump bolt (to rear crankshaft bearing cap)				
	First pass	20		15
	Final pass	+ 65 degrees		
Oil pump cover bolt		12	106	
Rear main (crankshaft) oil seal retainer bolts and nuts		12	106	

Torque Specifications (continued)

Description		Nm	lb-in.	lb-ft
Rear mount - sterndrive		51		38
Rear mount - inboard and tow sports				
Rear oil seal retainer nut and bolt		12	106	
Rear oil seal retainer stud		6	53	
Remote oil connector		34		25
Remote oil filter adapter nut / fitting		27		20
Valve cover bolt		12	106	
Seawater pump bracket		41		30
Spark plug				
	Initial installation (new cylinder head)	30		22
	All subsequent installations	15	132	
Starter motor bolt		50		37
Thermostat housing bolt		41		30
Throttle body fasteners				
	Nut	10	88	
	Stud	9	80	
Transmission to flywheel housing		68		50
Upper intake manifold stud				
	First pass	5	44	
	Final pass	10	89	
Valve lifter guide retainer bolt		25		18
Water circulating pump bolt		45		33
Water pump pulley bolt		25		18
Water temperature sender		27		20

General Information

Repair Procedures

Some of the repairs in this section must be completed with the engine removed from the boat. Engine removal depends upon the type of repair and boat design. Place the engine on a repair stand for major repairs.

When engine removal is not required, ensure that the battery cables are disconnected at the battery prior to performing any on-board repair procedures.

Lubricate all moving parts during reassembly with clean engine oil or as specified. Apply appropriate lubricant, sealant, or adhesive to all fasteners as specified.

Special Notice

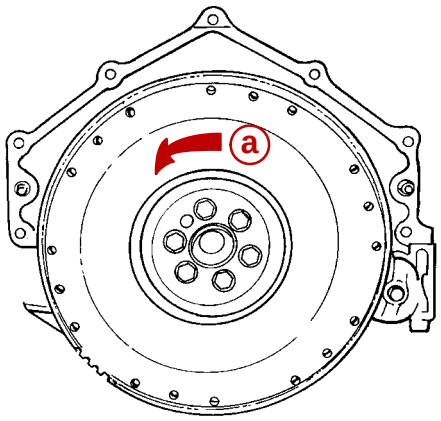
Servicing the cylinder heads and engine block is the primary concern of this section. Some external components that are not mentioned in the procedural steps must be removed. Refer to appropriate sections of this manual for complete service information concerning any component hindering service or repairs to the cylinder heads and engine block.

Engine Rotation

Engine rotation is described when observed from the rear of the engine (transmission or sterndrive end) looking forward (water pump end).

Propeller rotation is not necessarily the same as engine rotation.

IMPORTANT: All engines covered by this service manual are left-hand (LH) rotation.



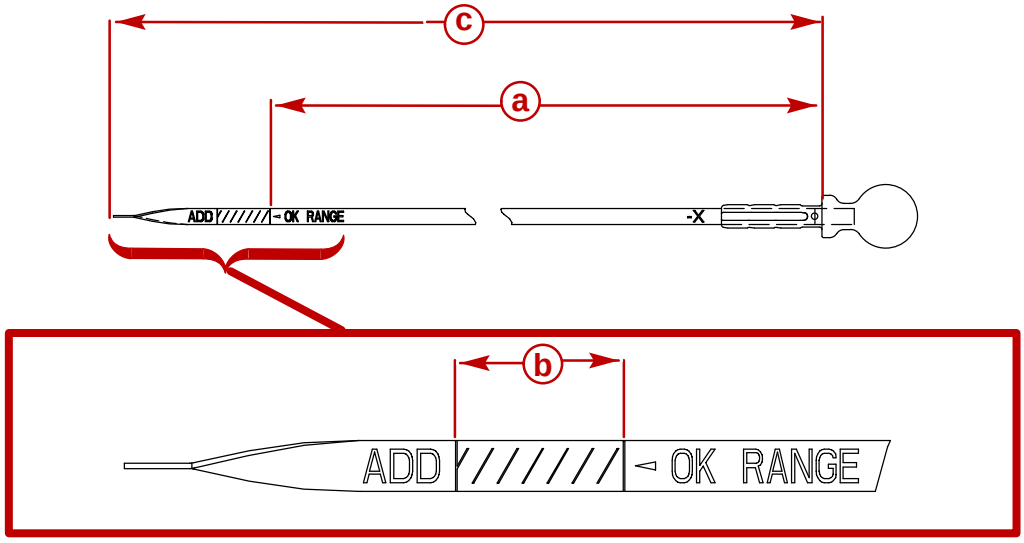
72001

a - Left hand-rotation (COUNTERCLOCKWISE)

Crankcase Oil Dipstick Measurements

NOTICE
Unit Of Measurement: millimeters (inches)

Part Number	Length A	Length B	Length C	Model
861942-2	330 (13)	19 (3/4)	396 (15-1/2)	All MIE engines
861942-3	349 (14)	13 (1/2)	396 (15-1/2)	All MIE engines with remote drive transmissions
861942-7	787 (31)	19 (3/4)	845 (33-1/4)	All MCM service and tow sports engines
861942-9	851 (33-1/2)	13 (1/2)	895 (35-1/4)	All (MCM) engines



77646

a - Length A
b - Length B
c - Length C

Gasoline Engine Compression Test

IMPORTANT: Use a fully charged battery.

1. With the engine cold, verify that the battery is fully charged.
2. Ground the ignition coil wire that goes to the distributor cap directly to engine ground stud and remove all spark plugs.

IMPORTANT: Ground the ignition coil wire that goes to the distributor cap directly to engine ground stud to prevent a possibility of a spark from the disconnected spark plug wires. When using a Remote Starter tool to crank the engine over, some engines may have the ignition coil energized by the R terminal in the starter solenoid even though the key switch and the lanyard stop switch is in the OFF position.

3. Open throttle plate completely.
4. Starting with the compression gauge at 0, crank the engine through 4 compression strokes (4 puffs).
5. Record compression for each cylinder.
6. If some cylinders have low compression, use a pump type oil can to inject 3 squirts of oil into each combustion chamber through the spark plug hole. Do second compression check on each cylinder.

NOTE:*No cylinder should read less than 100 psi (690 kPa).*

NOTE:*Compression recorded on any one cylinder should not be less than 70% of the highest cylinder. Example: If the highest cylinder has 150 psi (1035 kPa), the lowest allowable pressure for any other cylinder would be 105 psi (725 kPa). [150 X 70% = 105 psi (1035 X 70% = 725 kPa)].*

Normal: Compression builds up quickly and evenly in each cylinder.

Piston rings leaking: Compression low on first stroke then increases on following strokes but does not reach normal. Compression improves considerably with 3 squirts of oil.

Valves leaking: Compression low on first stroke and does not build up on following strokes or with 3 squirts of oil.

If 2 adjacent cylinders have lower than normal compression: Inject 3 squirts of oil into the cylinders. If the compression does not increase, the cause may be a blown head gasket between cylinders.

Using Air to Test Combustion Chamber

If a low cylinder is found during the compression test, the use of air pressure can help you find out if the engine has a valve or piston problem.

1. Open throttle plates completely.
2. With spark plugs still removed, rotate the engine until number 1 piston is at TDC on the compression stroke. This will ensure that both valves are closed.
3. Rotate the crankshaft 90 degrees to put the next cylinder in the firing order at TDC.

NOTE:*If you want to test just the cylinder with low compression, find its position in the firing order. Rotate the crankshaft the same number of degree increments as that cylinder is from number 1 cylinder in the firing order. Example: V6 with 1-6-5-4-3-2 firing order. Number 4 is the cylinder that you want to test. It is the third increment from number 1 cylinder TDC. Rotate crankshaft three 120 degree increments to bring number 4 cylinder to TDC on its compression stroke.*

4. Hold crankshaft balancer bolt with large wrench to prevent the crankshaft from rotating when applying air pressure to the cylinder.
5. Use a compression gauge style air adapter hose to thread into the spark plug hole.
6. Using an air hose, apply 138-206 kPa (20-30 psi) air pressure through this adapter hose into the cylinder to be tested. Ensure that the crankshaft does not rotate.

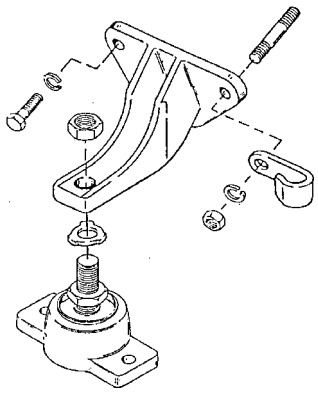
If air can be heard coming out of the throttle plates, the intake valve may be leaking.

If air can be heard coming out of the exhaust, the exhaust valve may be leaking.

If a large amount of air can be heard or felt coming out of the oil fill cap in the rocker arm cover, the piston or piston rings may be leaking. A small amount of air will leak past the piston rings in this test.

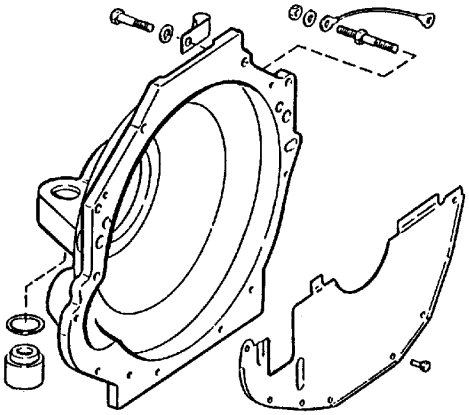
Engine Mounts

Exploded Views



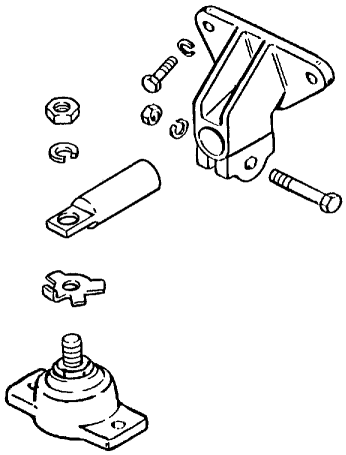
72317

Front mount - all sterndrive (MCM) models



72318

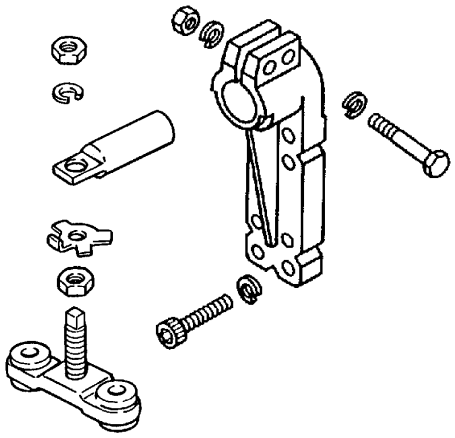
Rear mount / flywheel housing - all sterndrive (MCM) models



72319

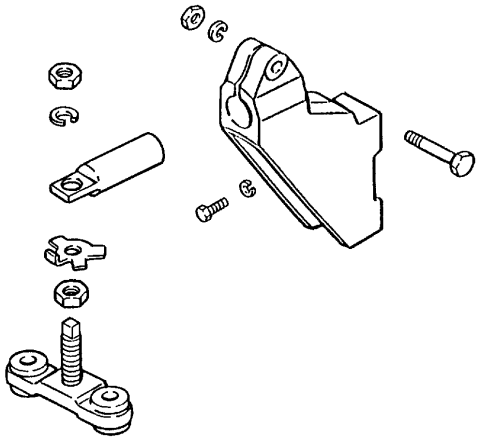
Front mount assembly - all inboard (MIE) models and tow sports models

Exploded Views (Continued)



73055

Rear mount assembly - most inboard (MIE) and tow sports models



73056

Typical rear mount assembly - inboard (MIE) and tow sports models with Velvet Drive in-line transmission

Valve Cover

Removal

NOTE:*It may be necessary to remove the exhaust manifold before removing a valve cover. Refer to* ***Section 7*** *for exhaust manifold removal.*

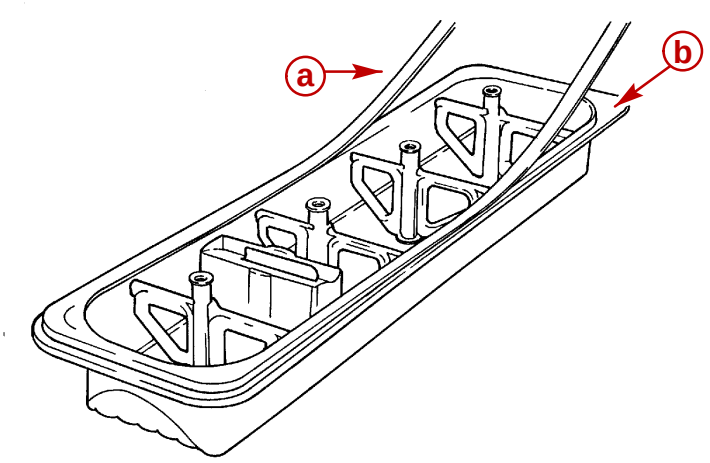
1. Disconnect crankcase ventilation hoses.
2. Remove any items that interfere with the removal of valve covers.
3. Remove valve covers.

Cleaning and Inspection

1. Clean gasket material from all sealing surfaces.
2. Clean sealing surfaces on cylinder head and valve cover with degreaser.

Installation

1. Place new valve cover gasket in position.



72324

a - Gasket
b - Sealing surface

2. Install valve cover. Torque bolts.

Description	Nm	lb-in.	lb-ft
Valve cover bolt	12	106	

3. Install any items that were removed.
4. Connect crankcase ventilation hoses.
5. Supply cooling water to the power package.
6. Start engine and check for oil leaks.

Rocker Arm / Valve Pushrod

Removal

NOTE:*When servicing only one cylinder's rocker arms, bring that cylinder's piston up to TDC (Top Dead Center) before removing rocker arms. When servicing all rocker arms, bring cylinder number 1 piston up to TDC before removing rocker arms.*

1. Remove valve covers.
2. Remove rocker arm assemblies and valve pushrods.

IMPORTANT: Organize rocker arm assemblies and valve pushrods in a rack for reassembly in their original locations.

Cleaning

1. Clean rocker arm assemblies and valve pushrods.
2. Clean valve pushrod oil passages.
3. Dry parts with compressed air.

Inspection

1. Inspect all contact surfaces for excessive wear or scoring.
2. Ensure valve pushrod oil passage is not restricted.
3. Roll valve pushrod on a flat surface and inspect shafts for bends.
4. Replace all damaged parts.

Installation

1. Lubricate the outer surfaces and ends of valve pushrods.

Description	Where Used	Part Number
Johnson Engine Prelube	Valve pushrod surface	92-801779

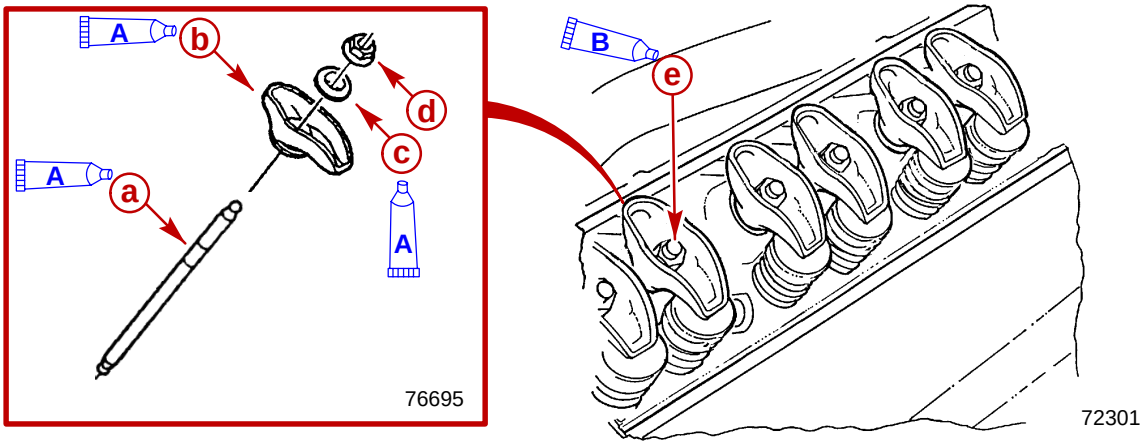
2. Install the valve pushrods in their original locations. Ensure that the valve pushrods seat in the lifter socket.
3. Lubricate the rocker arm and rocker arm ball contact surfaces.

Description	Where Used	Part Number
Johnson Engine Prelube	Rocker arm and rocker arm ball contact surfaces	92-801779

4. Lubricate the threads of the rocker arm studs.

Description	Where Used	Part Number
80W Gear Lube	Rocker arm stud	Obtain locally

5. Install the rocker arms, rocker arm balls, and rocker arm nuts in their original locations.



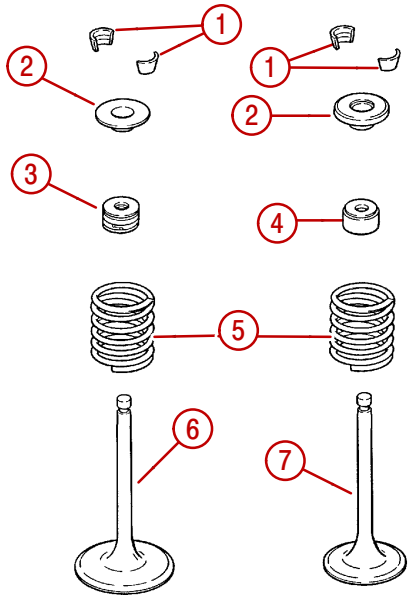
a - Pushrod
b - Rocker arm
c - Rocker arm ball
d - Rocker arm nut
e - Rocker arm stud

Description		Where Used	Part Number
A	Johnson Engine Prelube	Valve pushrod surface, rocker arm, and rocker arm ball contact surfaces	92-801779
B	80W Gear Lube	Rocker arm stud	Obtain locally

6. Adjust valve clearance, refer to Valve Adjustment.

Valve Stem Oil Seal / Valve Spring - Cylinder Head Installed

Exploded View



78152

1 - Valve locks
2 - Valve spring cap
3 - Intake valve stem oil seal
4 - Exhaust valve stem oil seal
5 - Valve spring
6 - Intake valve
7 - Exhaust valve

Removal

1. Remove valve cover.
2. Remove spark plug of affected cylinder.
3. Remove rocker arm assembly.

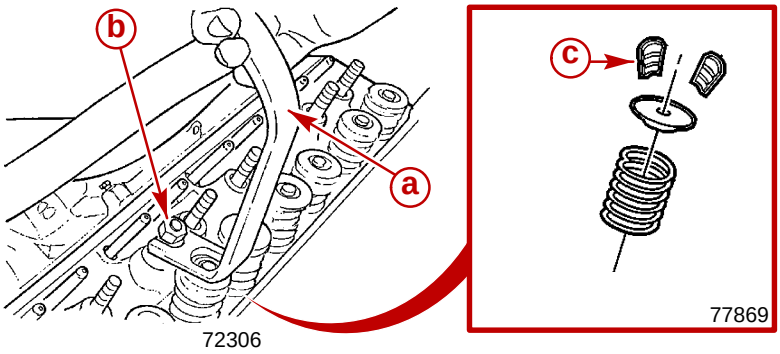
IMPORTANT: Keep air pressure in cylinder while springs, caps, and valve locks are removed or valves will fall into cylinder.

4. Install Spark Plug Port Adapter in spark plug hole and apply compressed air to hold valves in place.

Description	Part Number
Spark Plug Port Adapter	J23590

NOTE:*If compressed air is not available, piston may be brought up to TDC and used to keep valves from falling out of valve guides.*

5. Using Valve Spring Compressor under rocker arm nut, compress valve spring and remove valve locks.



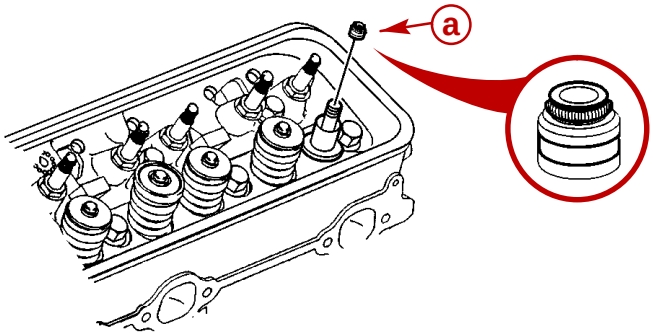
a - Valve Spring Compressor
b - Rocker arm nut
c - Valve locks

Description	Part Number
Valve Spring Compressor (cylinder head on engine)	J5892–D

6. Slowly release Valve Spring Compressor.
7. Remove valve spring cap and valve spring.

IMPORTANT: If compressed air was not available, do not turn crankshaft while valve springs, retainers and locks are removed or valves will fall into cylinder.

8. Remove and discard valve stem oil seal.



Typical

a - Valve stem oil seal

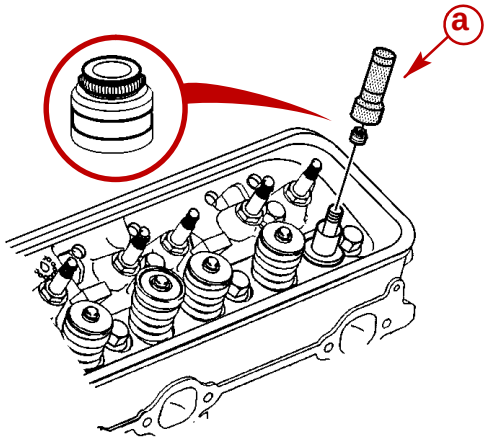
Installation

IMPORTANT: The intake valve stem oil seal is black. The exhaust valve stem oil seal material is either brown with a white paint stripe on the outer diameter or it is red with no paint stripe. Also, the letters “EX” are molded into the top of the exhaust valve stem oil seal.

1. Select the appropriate intake or exhaust valve stem oil seal.
2. Coat the outside surface of the valve stem bore and all surfaces of the valve stem oil seal with clean engine oil.

Description	Where Used	Part Number
Engine Oil	Valve stem bore and valve stem oil seal	Obtain locally

3. Install the valve stem oil seal onto the valve stem and push down until it is seated against the cylinder head.
4. Install Valve Stem Seal Installer and press the valve stem oil seal until the tool contacts the spring seat.



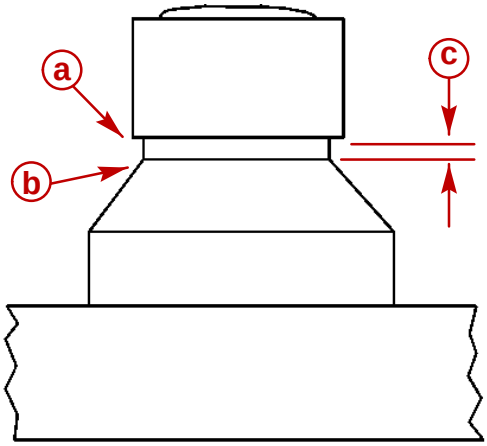
77867

Typical

a - Valve Stem Seal Installer

Description	Part Number
Valve Stem Seal Installer	J42073

5. For all intake and exhaust valves, ensure that the installed height (the gap between the bottom edge of the valve stem oil seal and the cylinder head valve guide boss) is as specified.



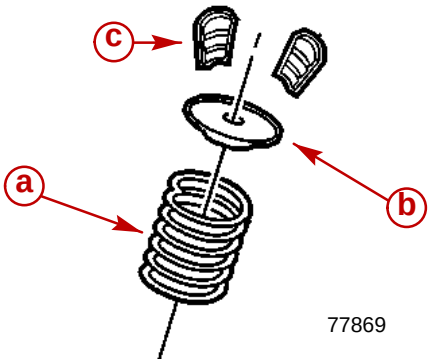
77868

a - Bottom of valve stem oil seal
b - Valve guide boss
c - Installed height (gap)

Description		**5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)**
Valve stem oil seal	Installed height[1]	1-2 mm (0.0394-0.0787 in.)

[1] *Measured from the top of the valve guide boss to the bottom of the valve stem oil seal.*

6. Install the valve spring.
7. Place the valve spring cap on valve spring.



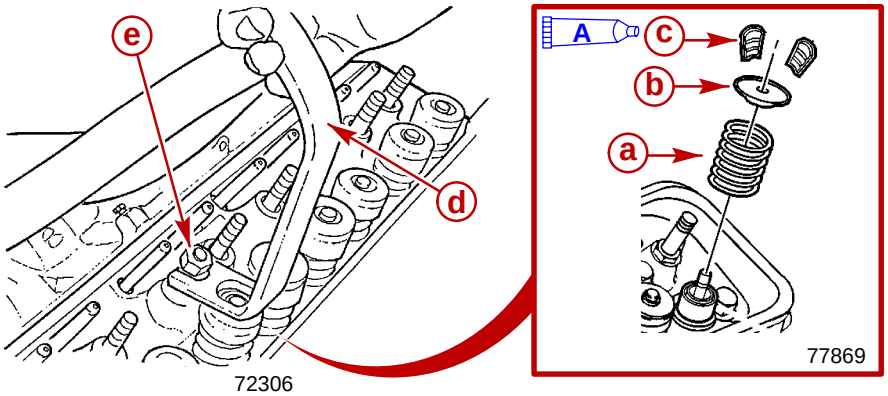
77869

a - Valve spring
b - Valve spring cap
c - Valve locks

⚠ CAUTION

Improperly compressed springs or improperly locked valve caps could allow the spring to be ejected with tremendous force, which could cause personal injury. Use care when compressing the valve springs or releasing the valve spring compressor tool.

8. Temporarily install the rocker arm nut onto the corresponding stud.
9. Coat the valve stem locks with the lubricant to hold them in place.



a - Valve spring
b - Valve spring cap
c - Valve stem locks
d - Valve Spring Compressor
e - Rocker arm nut

Description		Where Used	Part Number
A	Needle Bearing Assembly Lubricant	Valve stem locks	92-082868A1

10. While compressing valve spring with Valve Spring Compressor, install the valve stem locks.

Description	Part Number
Valve Spring Compressor (cylinder head on engine)	J5892–D

11. Ensure that the valve stem locks are seated properly in the groove of the valve stem.
12. Slowly release Valve Spring Compressor and remove the rocker arm nut.
13. Install valve pushrods and rocker arm assemblies (new cylinder head)
14. Remove the Spark Plug Port Adapter.

Description	Part Number
Spark Plug Port Adapter	J23590

15. Adjust valves; refer to Valve Adjustment.
16. Install valve cover.
17. Install and torque spark plugs.

Description		Nm	lb-in.	lb-ft
Spark plug				
	Initial installation (new cylinder head)	30		22
	All subsequent installations	15		11

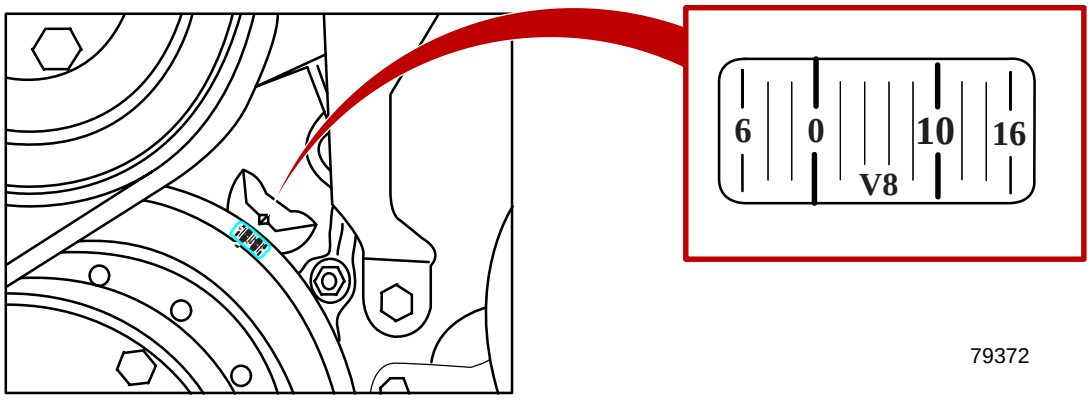
Valve Adjustment

Engine Stopped

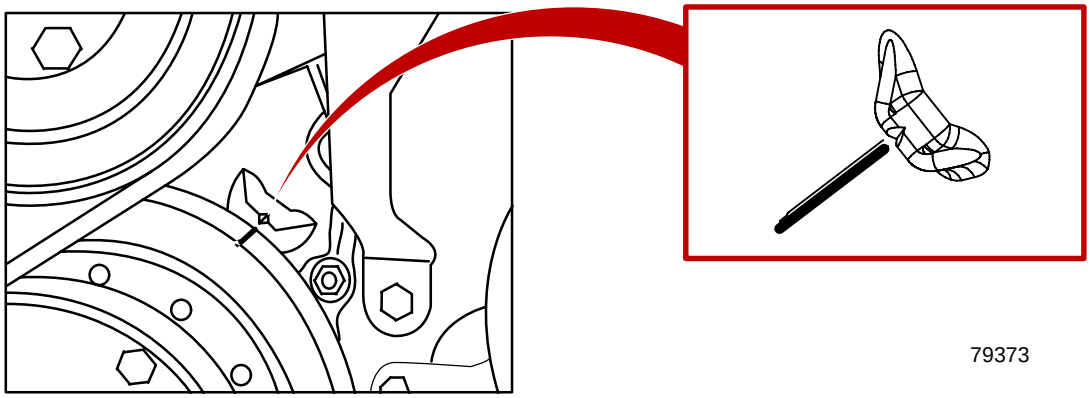
With valve cover removed, adjust valves when lifter is on low part of camshaft lobe.

NOTE:*Ensure engine is in cylinder number 1 firing position by placing fingers on cylinder number 1 valves as mark on crankshaft balancer comes near "0" mark on timing tab. If valves move as marks align the engine is in cylinder number 6 firing position and should be rotated 360 degrees to cylinder number 1 firing position.*

1. Turn engine in direction of engine rotation until mark on crankshaft balancer lines up with center "0" mark on timing tab.



Carbureted engine models "0" mark on crankshaft balancer

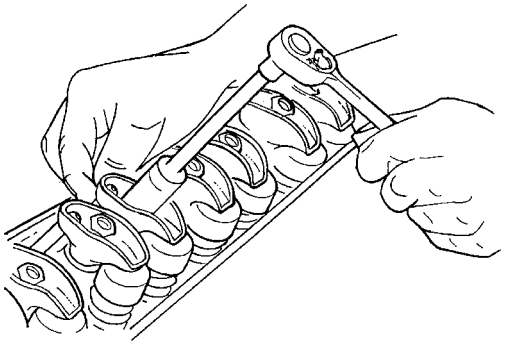


MPI engine models "0" mark on crankshaft balancer

2. With engine positioned as in Step 1., adjust the following valves.

Description	Cylinder Number
Exhaust valves	1-3-4-8
Intake valves	1-2-5-7

3. Adjust the valves indicated as follows:
   a. Loosen rocker arm nut until valve lash is felt at valve pushrod.
   b. Tighten rocker arm nut until all valve lash is removed. Zero valve lash can be felt by moving the valve pushrod up and down between the thumb and forefinger until there is no more vertical movement of the pushrod.
   c. Tighten the rocker arm nut an additional turn (360 degrees). No other adjustment is required.



72300

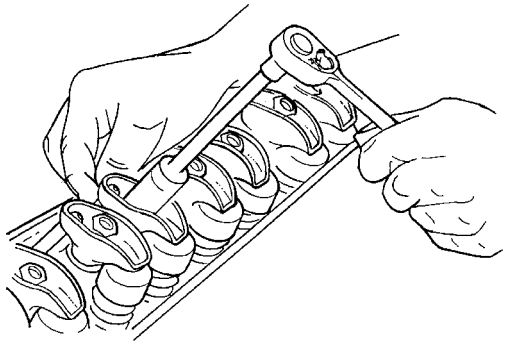
Description	5.0 l (305 CID) / 5.7 l (350 CID) / 6.2 l (377 CID)
Intake and exhaust	Rotate the valve rocker arm nut CLOCKWISE 360 degrees (1 turn) from zero clearance

4. Turn engine in direction of engine rotation 360 degrees until timing tab “0” mark and crankshaft balancer mark are aligned. This is cylinder number 6 firing position.

5. With engine positioned as in Step 4., adjust the following valves.

Description	Cylinder Number
Exhaust valves	2-5-6-7
Intake valves	3-4-6-8

6. Adjust the valves indicated as follows:
   a. Loosen rocker arm nut until valve lash is felt at valve pushrod.
   b. Tighten rocker arm nut until all valve lash is removed. Zero valve lash can be felt by moving the valve pushrod up and down between the thumb and forefinger until there is no more vertical movement of the pushrod.
   c. Tighten the rocker arm nut an additional turn (360 degrees). No other adjustment is required.

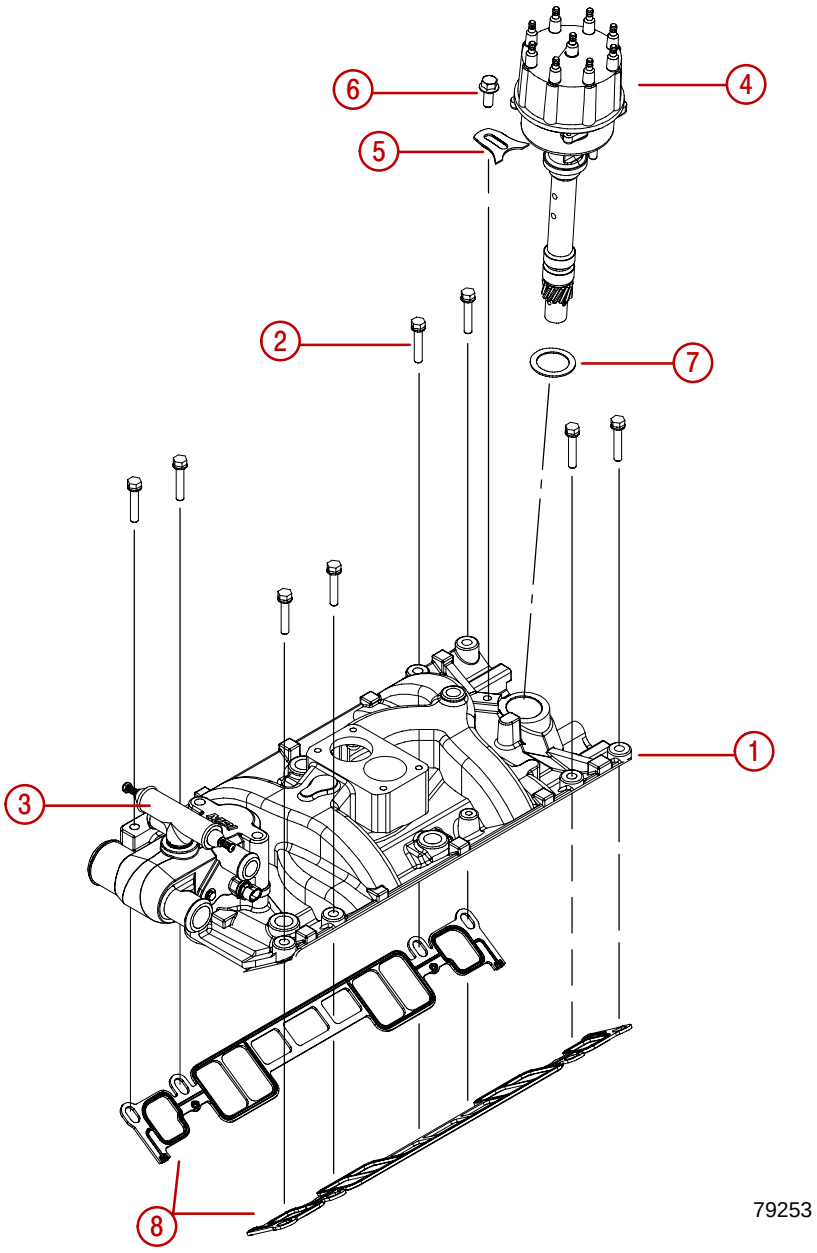


72300

Description	5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Intake and exhaust	Rotate the valve rocker arm nut clockwise 360 degrees (1 turn) from zero clearance

Intake Manifold For Carbureted Engines

Exploded View



1 - Intake manifold
2 - Intake manifold bolts (8)
3 - Thermostat housing
4 - Distributor
5 - Distributor clamp
6 - Distributor bolt
7 - Distributor gasket
8 - Intake manifold gaskets

Removal

NOTE: *Refer to* ***Section 5*** *for disassembly, cleaning, inspection, and reassembly of individual intake manifold components.*

1. Drain engine cooling systems.
2. Disconnect hoses from thermostat housing.
3. Disconnect electrical leads interfering with removal.
4. Disconnect crankcase ventilation hoses from rocker arm covers.
5. Disconnect throttle cable.
6. Disconnect fuel line from carburetor.

⚠ CAUTION

Avoid fuel system damage. Do not allow dirt or debris to enter the fuel system. Seal open ends of fuel lines and fuel system.

7. Remove the ignition coil wire.
8. Remove distributor cap and mark position of rotor on distributor housing. Also mark position of distributor housing on intake manifold.
9. Remove distributor.

IMPORTANT: Do not crank engine over after distributor has been removed.

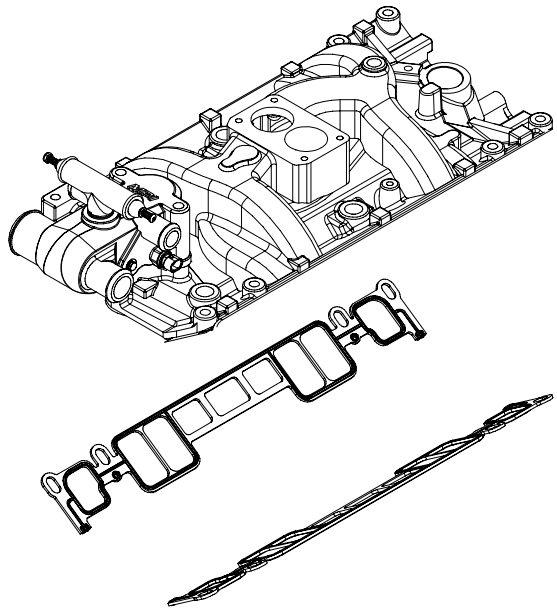
10. Remove oil pressure sending unit.
11. Disconnect any items that interfere with removal of intake manifold.

12. Remove intake manifold bolts.

IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block. Use extreme care to prevent damage to sealing surfaces.

13. Remove intake manifold assembly.

14. Remove and discard intake manifold gaskets.



NOTE:*If intake manifold requires replacement, transfer all remaining parts to new manifold.*

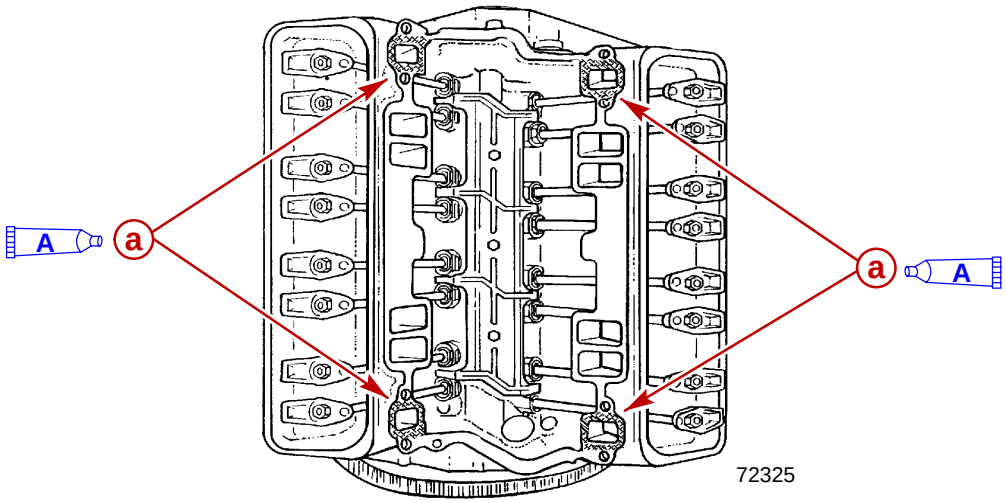
Cleaning and Inspection

IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase or intake ports.

1. Clean gasket material from all mating surfaces.
2. Inspect intake manifold for cracks or scratches. Machined surfaces must be clean and free of all marks and deep scratches or leaks may result.
3. Inspect intake passages for varnish buildup and other foreign material. Clean as necessary.

Installation

1. Apply sealant around port and starboard water passages of engine block.

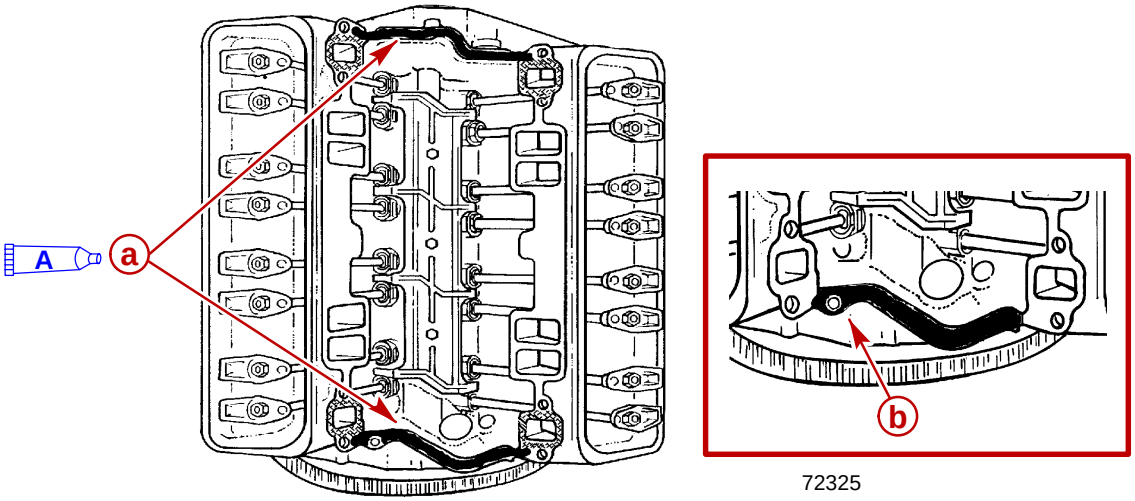


a - Water port passages

Description		Where Used	Part Number
A	Perfect Seal	Engine block water passages	92-34227-1

IMPORTANT: Do not get sealer into oil sending unit hole at rear of engine.

2. Apply a 5 mm (3/16 in.) wide bead of sealant to engine block.

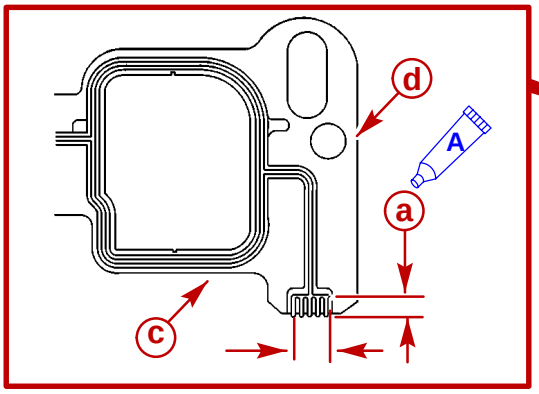


a - Bead of sealant
b - Oil sending unit hole

Description		Where Used	Part Number
A	Loctite 5900 Ultra-Black RTV Silicone Sealant	Block to intake manifold	92-809826

NOTE:*For proper adhesion, the intake manifold gasket must be installed while the adhesive is still wet.*

3. Align intake manifold gaskets with locator pins. Install intake manifold gaskets onto the cylinder heads.
4. Apply a 4 mm (5/32 in.) bead of sealant at each end of the intake manifold gasket on the top side.



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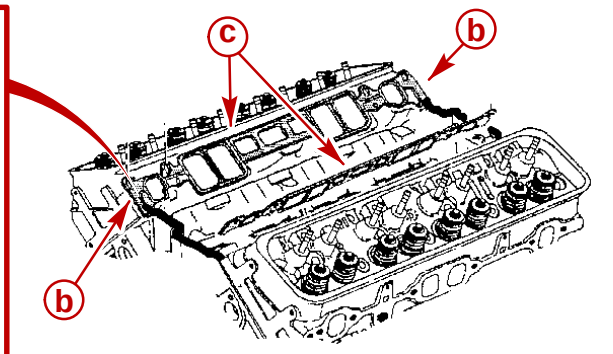


77833

a - Area of adhesive
b - Locator pin
c - Gasket
d - Locator pin hole

Description		Where Used	Part Number
A	Loctite 5900 Ultra-Black RTV Silicone Sealant	Intake manifold gaskets	92-809826

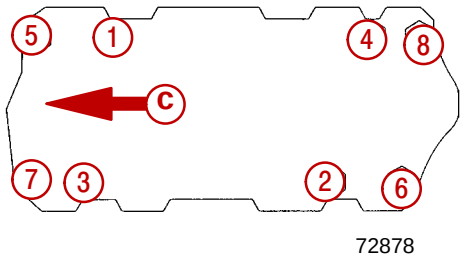
5. Carefully install intake manifold assembly onto engine block.
6. Apply sealant to threads of the intake manifold bolts.

Description	Where Used	Part Number
Loctite 242 Threadlocker	Intake manifold bolt	92-809821

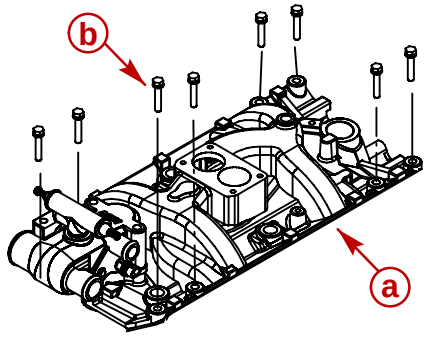
⚠ CAUTION

Avoid engine damage. Crankshaft bearing bore alignment may become distorted resulting in damage to the crankshaft bearings if intake manifold fastener tightening sequence and torque are done improperly. Always torque the bolts in sequence to the specified amount in each of the three passes required.

7. Torque intake manifold bolts in sequence and passes indicated.
   a. Torque sequence for carburetor or throttle body engines.



72878



79253

a - Intake manifold
b - Intake manifold bolts (6)
c - Front

Description		Nm	lb-in.	lb-ft
Intake manifold bolt				
All bolts in sequence	First pass	3	26.5	2
	Second pass	12	106.2	9
	Final pass	25	216.2	18

8. Connect all ignition and electrical leads.
9. Connect hoses to thermostat housing.
10. Install fuel line.
11. Connect crankcase ventilation hoses.
12. Install the distributor.
13. Install the ignition coil wire.
14. Connect any items that were disconnected.
15. Refill closed cooling system, if equipped.

⚠ CAUTION

Overheating caused by insufficient cooling water will result in engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

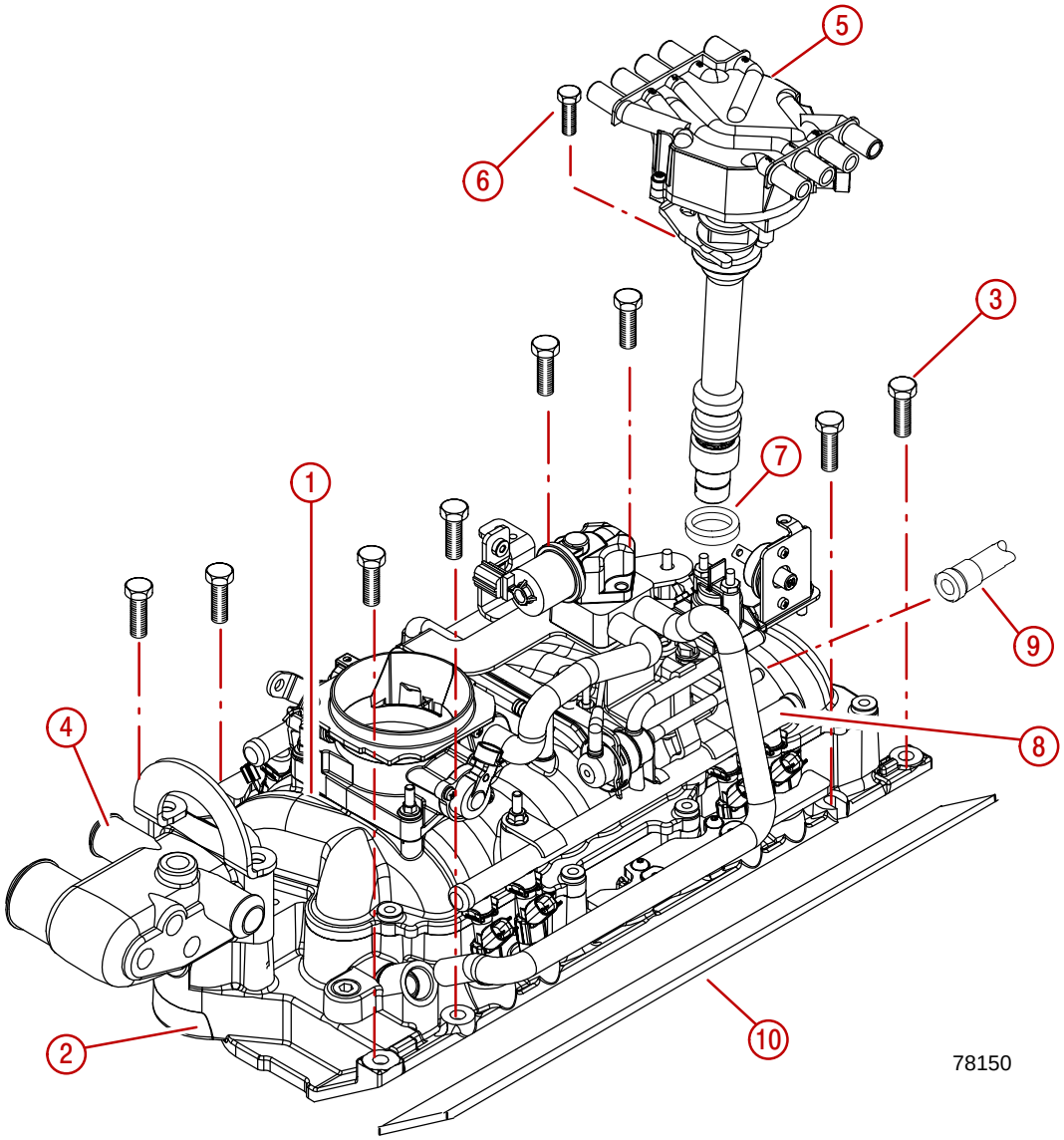
16. Provide cooling water to the engine.
17. Start engine.
18. Check hose connections, gaskets, and seals for leaks.
19. Inspect fuel line connections for fuel leaks.
20. Install the flame arrestor.

Description	Nm	lb-in.	lb-ft
Flame arrestor retainer bracket nut	12	108	

21. Install engine cover.

Intake Manifold For MPI Engines

Exploded View



1 - Upper intake manifold
2 - Lower intake manifold
3 - Lower intake manifold bolts
4 - Thermostat housing
5 - Distributor
6 - Distributor clamp and bolt
7 - Distributor gasket
8 - Fuel rail
9 - Fuel line
10 - Intake manifold gasket

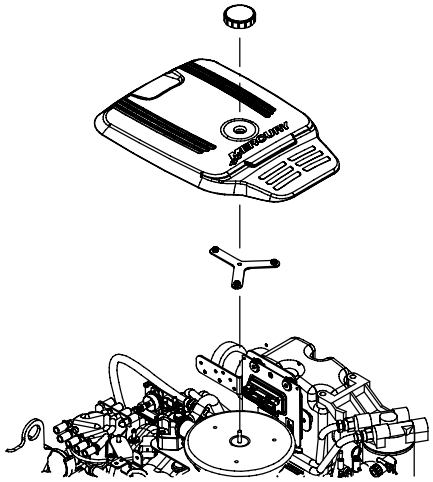
NOTE:*The upper and lower intake manifold parts may be removed as an assembly. Unless service is required, it is not necessary to remove individual intake manifold components other than as outlined.*

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables.
2. Remove the engine cover and the flame arrestor.

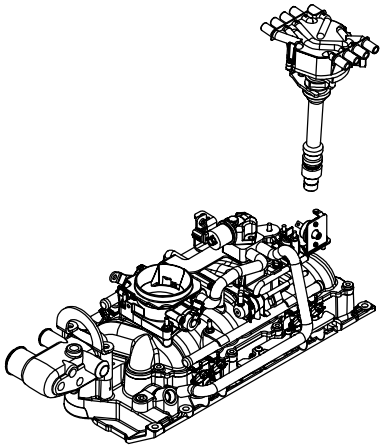


78020

3. Drain the cooling system.
4. Remove the hoses from the thermostat housing.
5. Disconnect the throttle cable from the throttle cable bracket and throttle body.
6. Disconnect the fuel line from the fuel rail.

Description	Part Number
Fuel Line Disconnect Tool	J44581

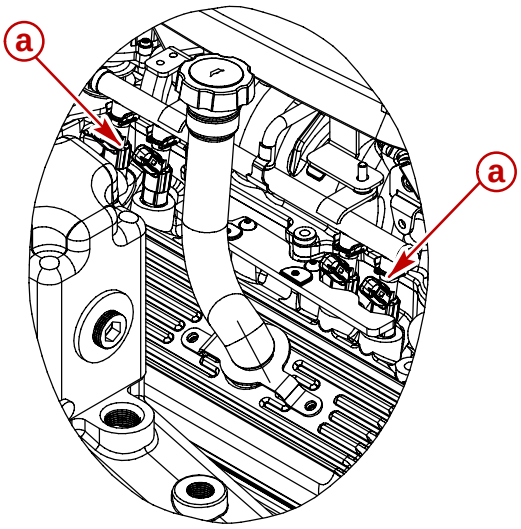
7. Remove the distributor.



77951

8. Disconnect the electrical harness from the fuel injectors.

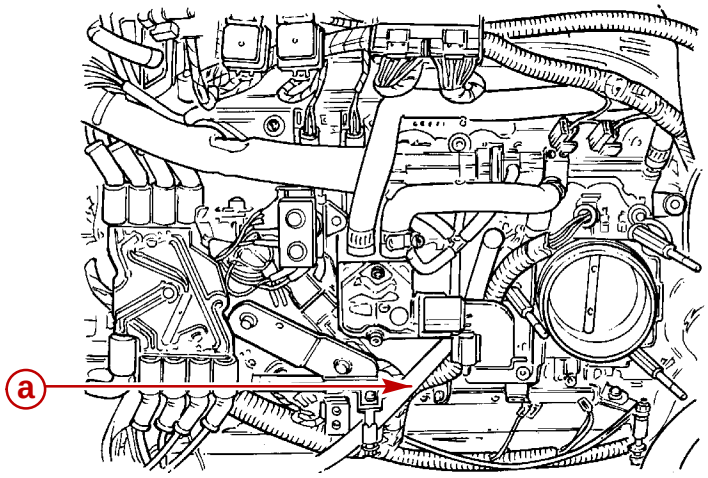
77842



Starboard side MIE shown, others similar

a - Fuel injector connections (8)

9. Disconnect the vacuum hose from the starboard valve cover.



77906

a - Vacuum hose

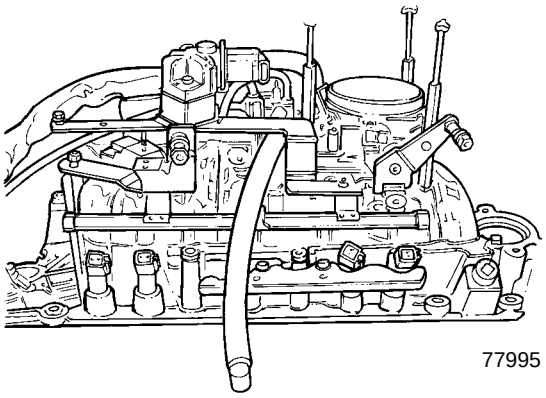
10. Remove the exhaust elbows.
11. Remove the valve covers.
12. Remove the lower intake manifold bolts.

IMPORTANT: The intake manifold may be removed as an assembly. Do not remove the specific intake manifold components unless component service is required.

⚠ CAUTION

Dirt or debris may enter the fuel system causing fuel system or engine failure. Seal the ends of the fuel system properly.

13. Remove the intake manifold assembly.

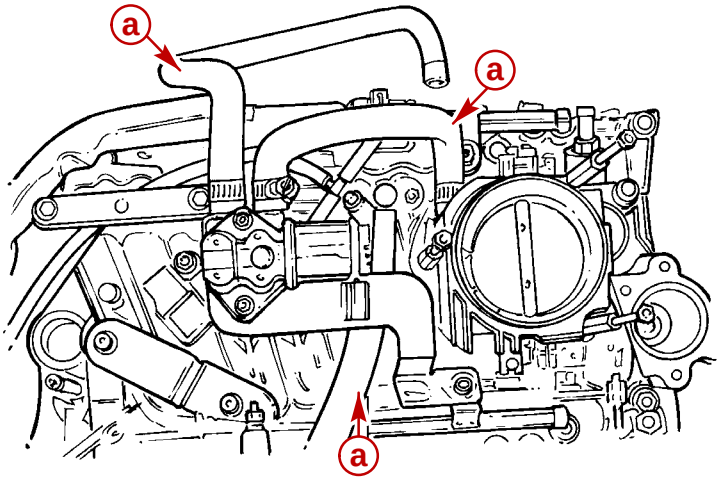


77995

14. Remove and discard the lower intake manifold gaskets.

Disassembly

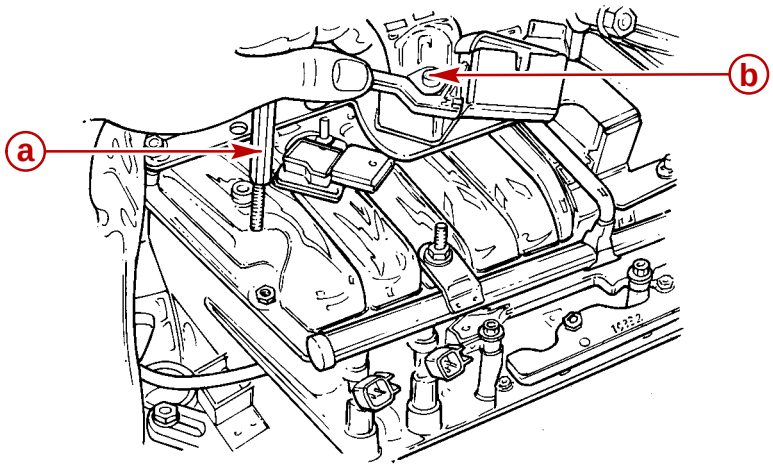
1. Remove all crankcase ventilation hoses.



77997

a - Hoses

2. Remove the throttle cable bracket nuts. The stud at the rear of the intake manifold may loosen instead of the nut.



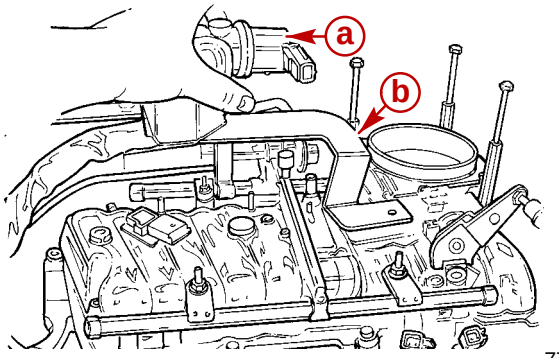
77998

Typical

a - Throttle cable stud
b - Throttle cable bracket

3. Remove the IAC bracket nuts.

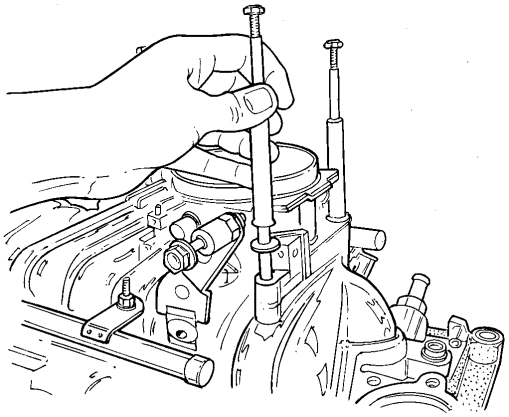
4. Remove the IAC and bracket.



77999

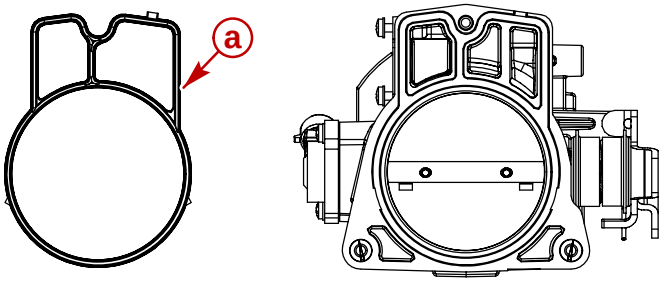
a - IAC
b - IAC bracket

5. Remove the ignition coil.
6. Remove the throttle body attaching studs.



78161

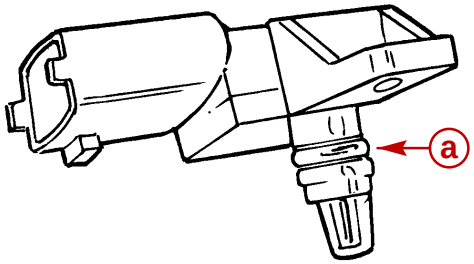
7. Remove the throttle body.
8. Remove and discard the throttle body sealing ring.



78158

a - Sealing ring

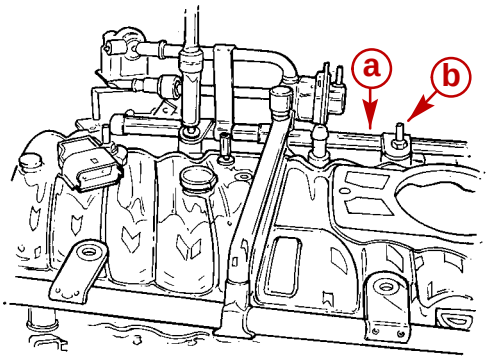
9. Remove the thermostat housing.
10. Remove the MAPT and discard the seal.



78083

a - Seal

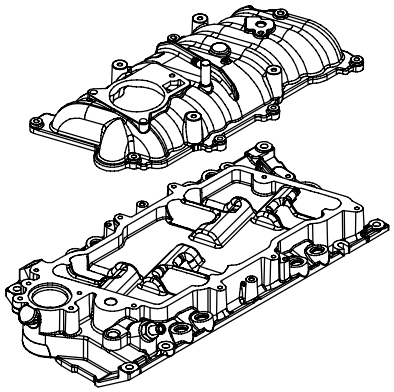
11. Remove the fuel rail studs.
12. Remove the fuel rail assembly.



78082

a - Fuel rail assembly
b - Fuel rail studs

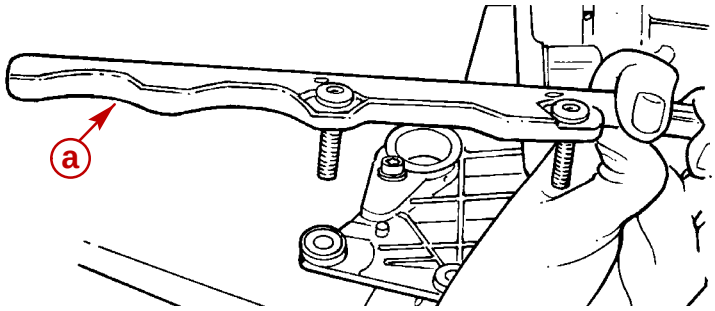
13. Do the following steps if complete disassembly is required.
    a. Remove the upper intake manifold studs.
    b. Remove the upper intake manifold.



78153

    c. Remove and discard the upper intake manifold to lower intake manifold gasket.

d. Remove the brackets on both sides of the lower intake manifold.



78085

a - Bracket

Cleaning and Inspection

1. Remove any gasket material from the intake manifold and cylinder head.
2. Clean the intake manifold or upper and lower intake manifolds in cleaning solvent.
3. Dry the intake manifolds with compressed air.
4. Inspect the intake manifolds for cracks or damage to the exterior surfaces, the gasket grooves, or the gasket sealing surfaces.
5. Inspect the cooling system passages for restriction.
6. Inspect the threads in the bolt holes for damage.

Assembly

1. Do the following steps if the intake manifold was completely disassembled.
   a. Install the brackets on both sides of the lower intake manifold.
   b. Install the new upper intake manifold to lower intake manifold gasket into the groove of the upper intake manifold.
   c. Install the upper intake manifold onto the lower intake manifold.
   d. If reusing the fasteners, apply adhesive to the threads of the upper intake manifold attaching studs.

Description	Where Used	Part Number
Loctite 242	Throttle body fasteners	92-809821

   e. Install the upper intake manifold attaching studs.
   f. Torque the upper intake manifold attaching studs.

Description		Nm	lb-in.	lb-ft
Upper intake manifold studs				
	First pass	5	44	
	Final pass	10	89	

2. Install the fuel rail assembly and injectors on the intake manifold.
3. If reusing the fasteners, apply adhesive to the threads of the fuel rail studs or bolts.

Description	Where Used	Part Number
Loctite 242	Throttle body fasteners	92-809821

4. Install the fuel rail studs.
5. Torque the fuel rail nuts.

Description	Nm	lb-in.	lb-ft
Fuel rail retainer nuts	3	27	

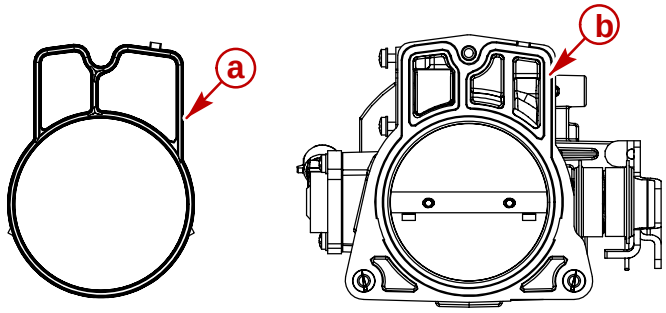
6. Install a new seal on the MAPT sensor.
7. Apply 1 drop of clean engine oil to the MAPT sensor seal.
8. Install the MAPT sensor into the upper intake manifold.

Description	Nm	lb-in.	lb-ft
Manifold air pressure and temperature sensor (MAPT)	6	53	

9. Install the ignition coil and the studs.
10. Torque the ignition coil studs.

Description	Nm	lb-in.	lb-ft
Ignition coil studs	12	106	

11. Install the thermostat housing using a new gasket.
12. Install a new throttle body sealing ring into the groove in the throttle body.



78158

a - Sealing ring
b - Groove in throttle body

13. Align the dowels and install the throttle body onto the upper intake manifold.
14. If reusing the fasteners, apply adhesive to the threads of the throttle body attaching studs.

Description	Where Used	Part Number
Loctite 242	Throttle body fasteners	92-809821

15. Install the throttle body attaching studs. Torque the studs.

Description	Nm	lb-in.	lb-ft
Throttle body studs	9	80	

16. Install the IAC bracket. Torque the nuts.

Description	Nm	lb-in.	lb-ft
IAC bracket nuts	15	132	

17. Install the throttle cable bracket. Torque the nuts.

NOTE:*Ensure that the stud and nut are threading correctly.*

Description	Nm	lb-in.	lb-ft
Throttle cable bracket nuts	19	168	

Installation

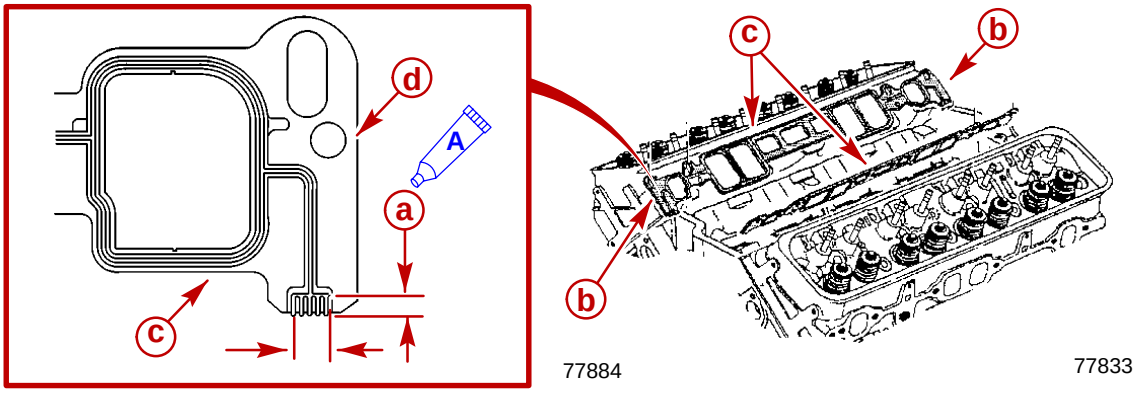
⚠ CAUTION

Excessive amounts of adhesive or sealer on gaskets or component surfaces may cause improper sealing resulting in intake manifold air or fluid leaks. Do not apply excessive amounts of adhesive or sealer.

1. Apply a 4 mm (5/32 in.) bead of adhesive at each end of the lower intake manifold gasket on the cylinder head side. Do not get sealer into oil sending unit hole.

NOTE:*For proper adhesion, the lower intake manifold gasket must be installed while the adhesive is still wet.*

2. Align lower intake manifold gaskets with locator pins. Install lower intake manifold gaskets onto the cylinder heads.



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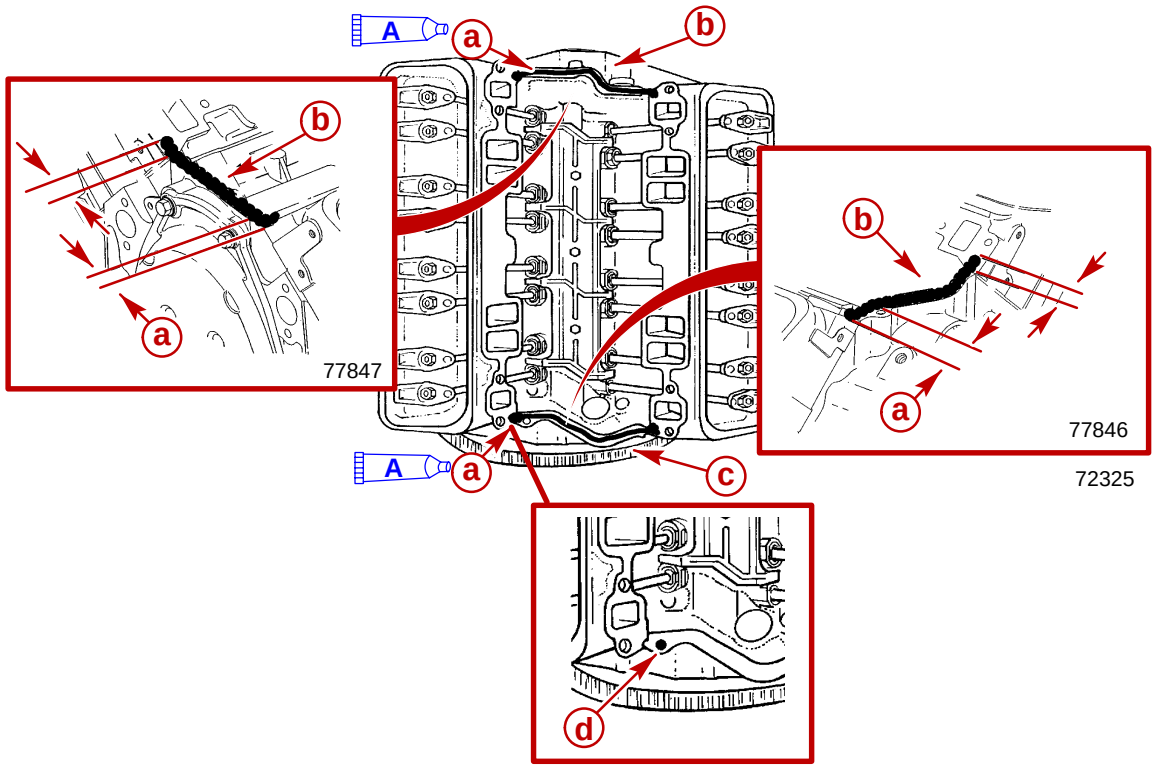
a - Area of adhesive
b - Locator pin
c - Gasket
d - Locator pin hole

Description		Where Used	Part Number
A	Loctite 5900 Ultra-Black RTV Silicone Sealant	Lower intake manifold gaskets	92-809826

3. Apply a 5 mm (13/64 in.) wide bead of adhesive to front and rear of engine block as shown. Extend adhesive bead 13 mm (1/2 in.) up on intake gaskets; avoid blocking the hole.



a - Bead of adhesive
b - Front top of engine block
c - Rear top of engine block
d - Hole

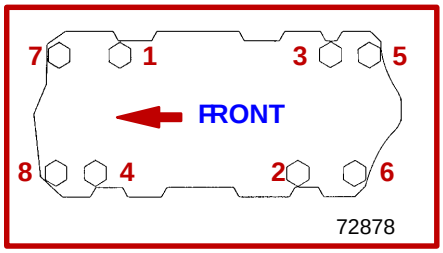
Description		Where Used	Part Number
A	Loctite 5900 Ultra–Black RTV Silicone Sealant	Engine block at the lower intake manifold sealing surfaces	92-809826

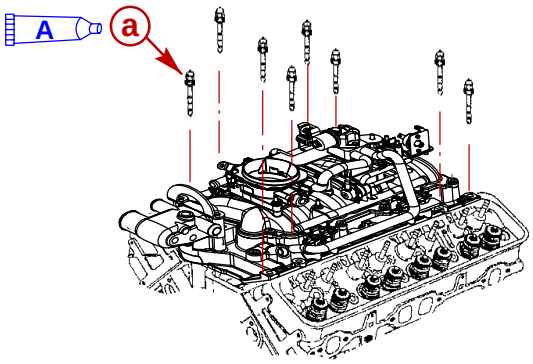
4. Coat threads of the lower intake manifold bolts with sealant.
5. Carefully install lower intake manifold or intake manifold assembly onto the engine block.

⚠ CAUTION

Avoid engine damage. Crankshaft bearing bore alignment may become distorted resulting in damage to the crankshaft bearings if intake manifold fastener tightening sequence and torque are done improperly. Always torque the bolts in sequence to the specified amount in each of the three passes required.

6. Torque lower intake manifold bolts in sequence and passes indicated.





a - Intake manifold bolts

Description		Where Used	Part Number
A	Loctite 242	Lower intake manifold bolt	92-809821

Description		Nm	lb-in.	lb-ft
Lower intake manifold bolt (each pass in sequence)				
	First pass	3	2.5	2
	Second pass	12	106.2	9
	Final pass	25		18

7. Install the valve covers.
8. Install the exhaust elbows.
9. Connect all ignition and electrical leads.
10. Connect hoses to thermostat housing.

11. Install fuel line to fuel rail.
12. Connect crankcase ventilation hoses.
13. Install the distributor.

Description	Nm	lb-in.	lb-ft
Distributor hold down clamp bolt	25		18

14. Install the ignition coil wire.
15. Install other ignition components and reconnect wires.
16. Connect any items that were disconnected.
17. Refill closed cooling system, if equipped.

⚠ CAUTION

Overheating caused by insufficient cooling water will result in engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

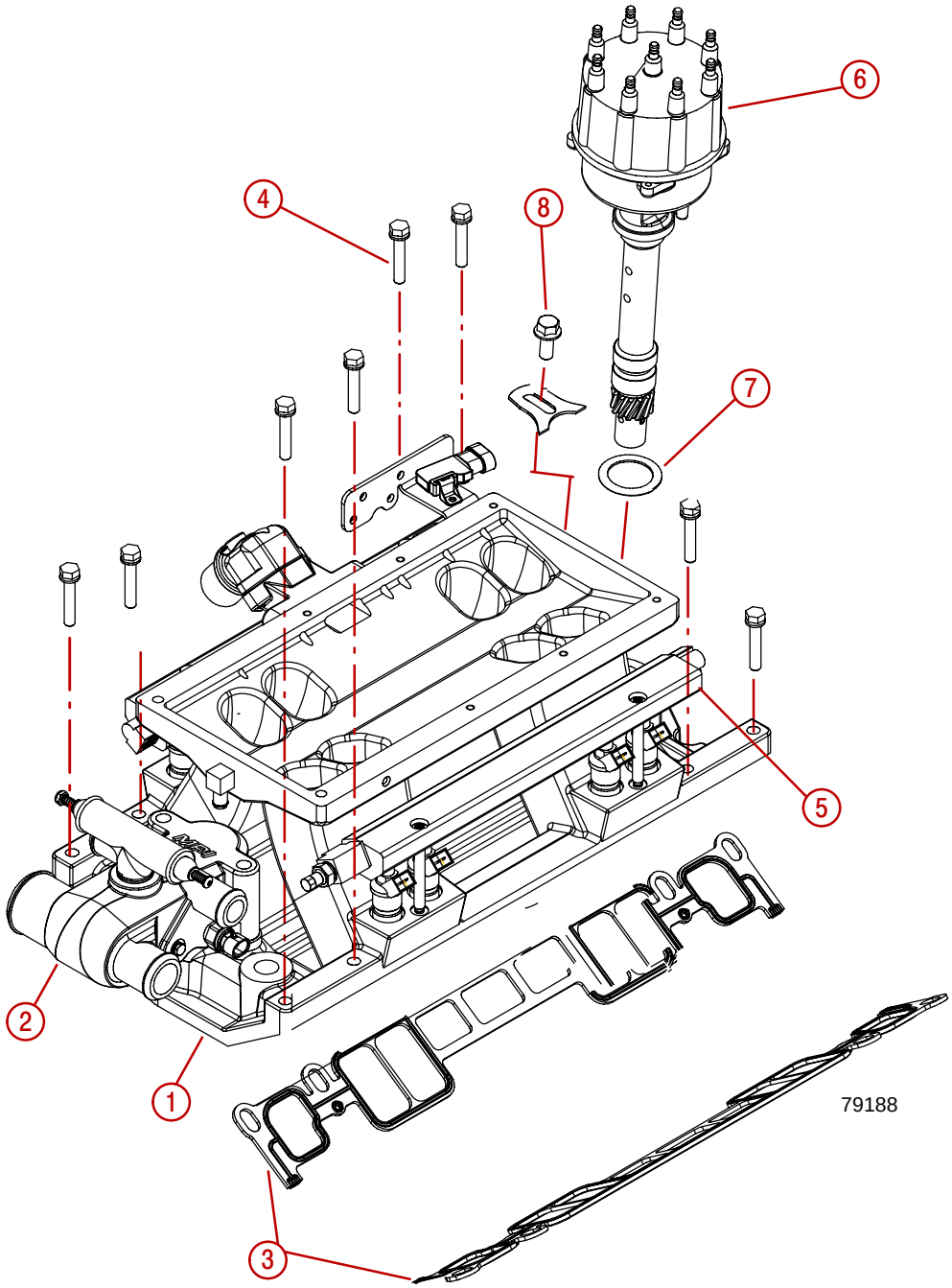
18. Provide cooling water to the engine.
19. Start engine.
20. Check hose connections, gaskets, and seals for leaks.
21. Inspect fuel line connections for fuel leaks.
22. Install the flame arrestor.

Description	Nm	lb-in.	lb-ft
Flame arrestor retainer bracket nut	12	108	

23. Install engine cover.

Intake Manifold For Scorpion Engines

Exploded View



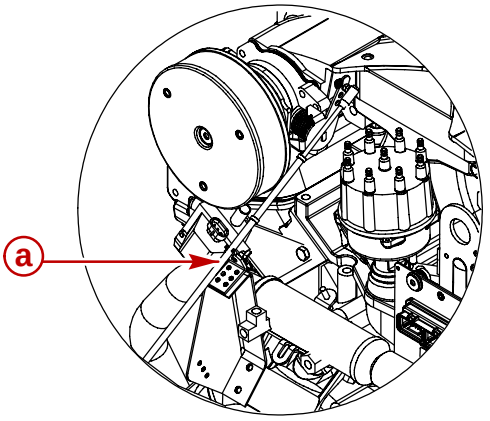
1 - Intake manifold
2 - Thermostat housing
3 - Intake manifold gasket
4 - Intake manifold bolts (8)
5 - Fuel rail (2)
6 - Distributor
7 - Distributor gasket
8 - Distributor clamp and bolt

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables from the battery.
2. Remove the PCV hose from flame arrestor.
3. Disconnect the throttle cable at the throttle body.

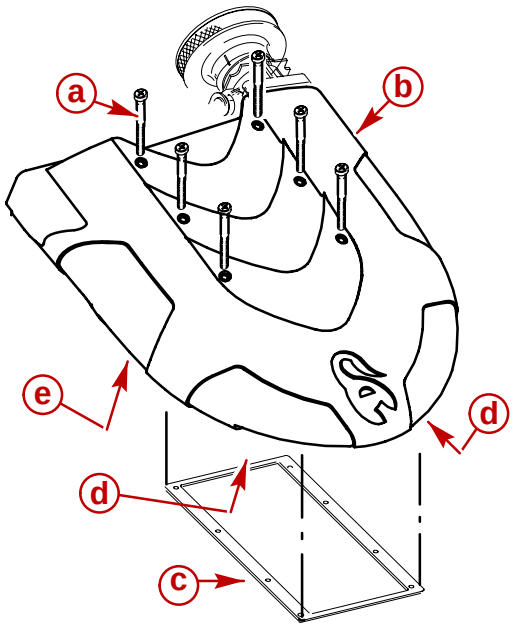


79128

a - Throttle cable

4. Disconnect the harness connector and the vacuum hose from the MAP sensor. The sensor is located on the underside of the plenum on the starboard side.

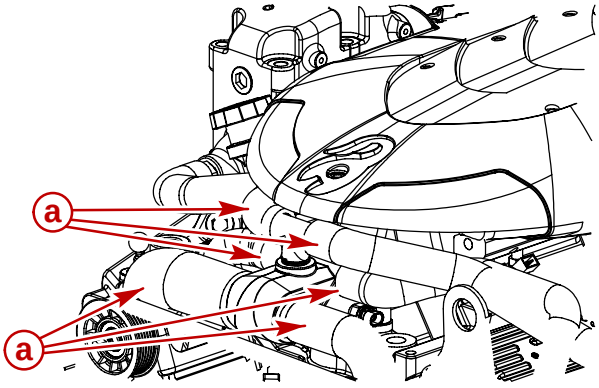
5. Remove the screws retaining the intake plenum to the manifold. Remove the 2 nuts from the underside of the plenum in the front. Remove the plenum and gasket.



75710

a - Screws (6)
b - Plenum
c - Gasket
d - Nuts
e - MAP sensor location

6. Drain the cooling system.
7. Remove the water hoses from the thermostat housing.



79143

a - Hoses

⚠ CAUTION

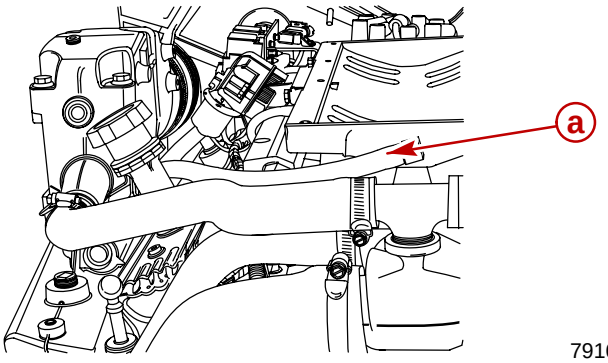
Avoid fuel system damage. Do not allow dirt or debris to enter the fuel system. Seal open ends of fuel lines and fuel system.

8. Disconnect the fuel line from the fuel rail.

9. Remove distributor cap and mark position of rotor on distributor housing. Also mark position of distributor housing on intake manifold.
10. Remove distributor.

IMPORTANT: Do not crank engine over after distributor has been removed.

11. Disconnect the electrical harness from the fuel injectors.
12. Disconnect the crankcase ventilation hose from the starboard valve cover.



79163

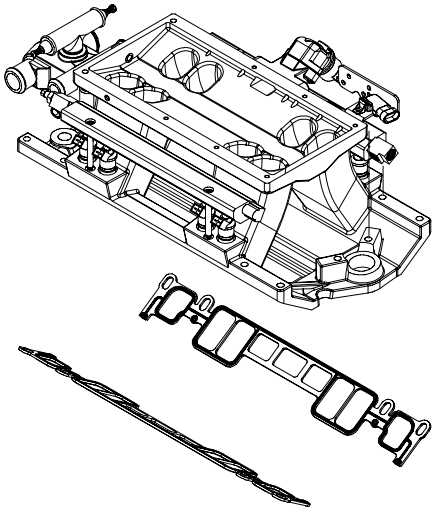
13. Remove the valve covers.
14. Remove the intake manifold bolts.

⚠ CAUTION

Dirt or debris may enter the fuel system causing fuel system or engine failure. Seal the ends of the fuel system properly.

IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block. Use extreme care to prevent damage to sealing surfaces.

15. Remove intake manifold assembly.



79188

16. Remove and discard intake manifold gaskets.

NOTE:*If intake manifold requires replacement, transfer all remaining parts to new manifold.*

Cleaning and Inspection

INTAKE MANIFOLD

IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase or intake ports.

1. Clean gasket material from all mating surfaces.
2. Inspect intake manifold for cracks or scratches. Machined surfaces must be clean and free of all marks and deep scratches or leaks may result.

IMPORTANT: Do not contaminate IAC filter and gasket components. Complete disassembly of the intake manifold is recommended before using cleaning solvent.

3. Inspect intake passages for varnish buildup and other foreign material. Clean as necessary.
4. Inspect the threads in the bolt holes for damage.

PLENUM

IMPORTANT: Use care when removing gasket material from intake manifold and plenum. Failure to do so could result in damage to the intake manifold and plenum.

1. Carefully remove all gasket material from intake manifold and plenum.
2. Inspect mating surfaces for damage that could affect gasket sealing.
3. Inspect plenum for cracks in casting.

IMPORTANT: Do not contaminate throttle body gasket components. Complete disassembly of the plenum is recommended before using cleaning solvent.

4. If needed, clean plenum in solvent and dry with compressed air.

Installation

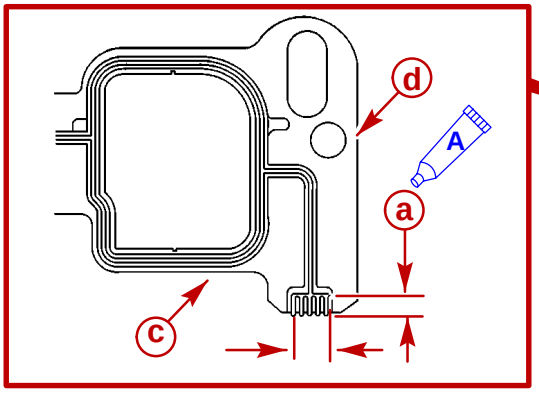
⚠ CAUTION

Excessive amounts of adhesive or sealer on gaskets or component surfaces may cause improper sealing resulting in intake manifold air or fluid leaks. Do not apply excessive amounts of adhesive or sealer.

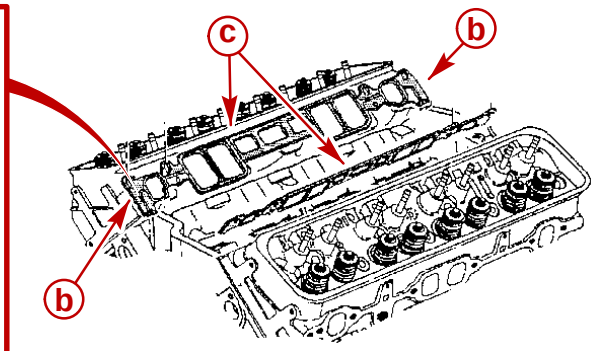
1. Apply a 4 mm (5/32 in.) bead of adhesive at each end of the lower intake manifold gasket on the cylinder head side. Do not get sealer into oil sending unit hole.

NOTE:*For proper adhesion, the lower intake manifold gasket must be installed while the adhesive is still wet.*

2. Align intake manifold gaskets with locator pins. Install intake manifold gaskets onto the cylinder heads.



77884

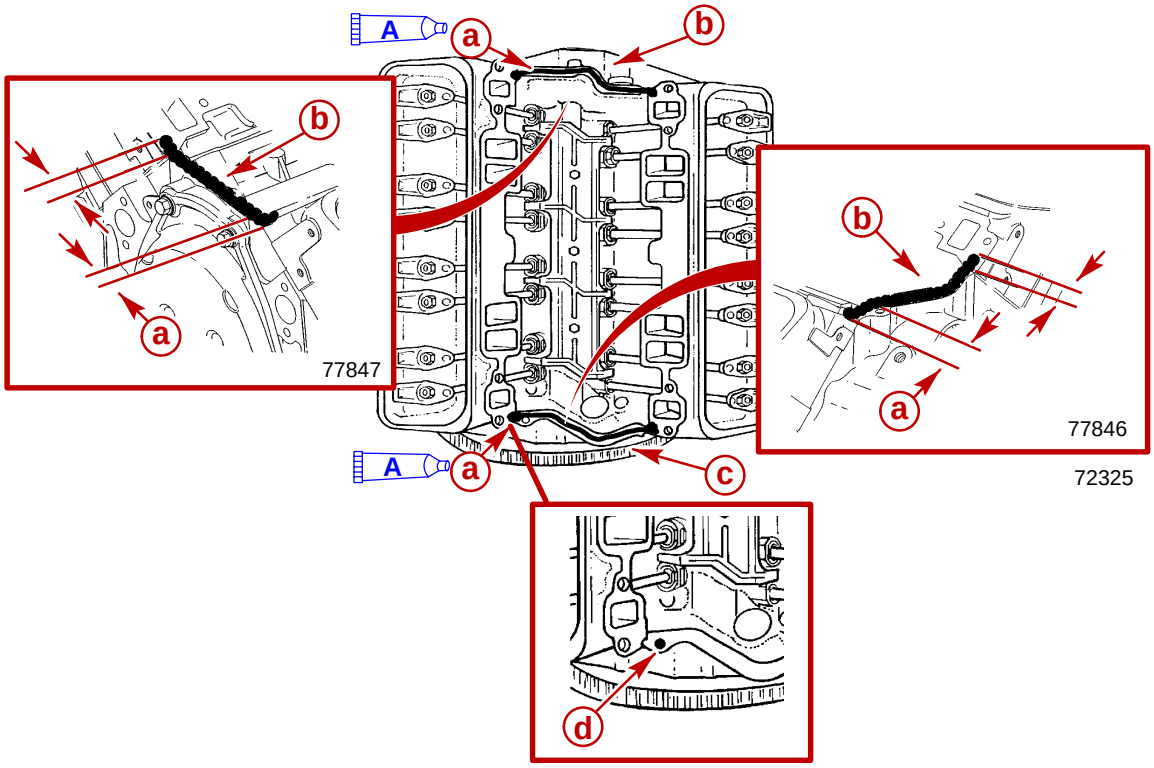


77833

a - Area of adhesive
b - Locator pin
c - Gasket
d - Locator pin hole

Description		Where Used	Part Number
A	Loctite 5900 Ultra-Black RTV Silicone Sealant	Intake manifold gaskets	92-809826

3. Apply a 5 mm (13/64 in.) wide bead of adhesive to front and rear of engine block as shown. Extend adhesive bead 13 mm (1/2 in.) up on intake gaskets; avoid blocking the hole.



a - Bead of adhesive
b - Front top of engine block
c - Rear top of engine block
d - Hole

Description		Where Used	Part Number
A	Loctite 5900 Ultra-Black RTV Silicone Sealant	Engine block the intake manifold sealing surfaces	92-809826

4. Coat threads of the intake manifold bolts with sealant.

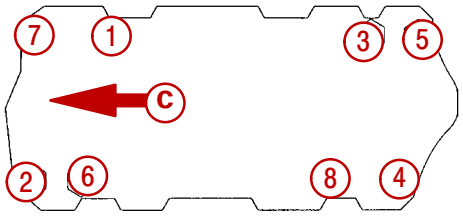
Description	Where Used	Part Number
Loctite 242	Intake manifold bolt	92-809821

5. Carefully install intake manifold onto the engine block.

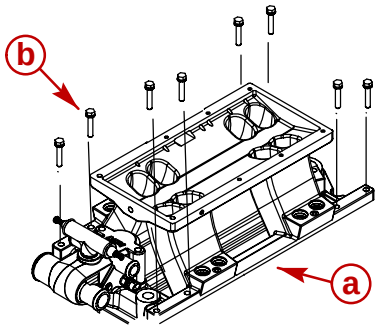
⚠ CAUTION

Avoid engine damage. Crankshaft bearing bore alignment may become distorted resulting in damage to the crankshaft bearings if intake manifold fastener tightening sequence and torque are done improperly. Always torque the bolts in sequence to the specified amount in each of the three passes required.

6. Torque intake manifold bolts in sequence and passes indicated.



72878



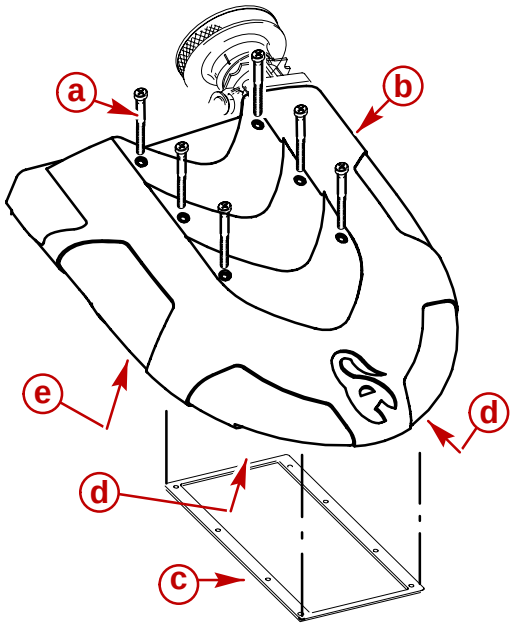
79191

a - Intake manifold
b - Intake manifold bolts (6)
c - Front

Description		Nm	lb-in.	lb-ft
Intake manifold bolt (each pass in sequence)				
	First pass	3	26.5	2
	Second pass	12	106.2	9
	Final pass	25	221.2	18

7. Install the valve covers.
8. Connect all ignition and electrical leads.
9. Connect hoses to thermostat housing.
10. Install fuel line to fuel rail.
11. Connect crankcase ventilation hose.
12. Install the distributor.
13. If not previously accomplished, remove all old gasket material from plenum gasket surface.
14. Position the new plenum gasket on the intake manifold. The word “FRONT” faces UP on the gasket at front edge of the intake manifold.
15. Place the plenum over the gasket.
16. Install the the screws retaining the intake plenum to the manifold. Install the 2 nuts on the underside of the plenum in front.

17. Torque the fasteners evenly in a diagonal pattern.

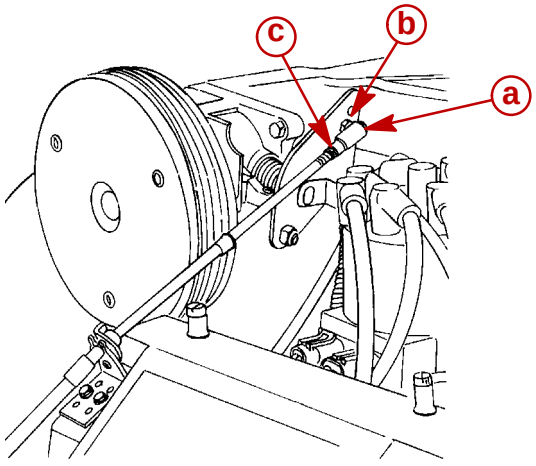


75710

a - Screws (6)
b - Plenum
c - Gasket
d - Nuts
e - MAP sensor location

Description		Nm	lb-in.	lb-ft
Torque the fasteners evenly in a diagonal pattern	Scorpion plenum screw	11	96	
	Scorpion plenum nut	11	96	

18. Install throttle cable and tighten locknut against cable end.



74838

a - Cable end
b - Throttle lever stud
c - Locknut

19. Refill closed cooling system, if equipped.

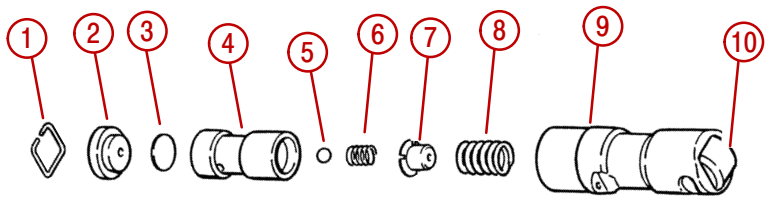
⚠ CAUTION

Overheating caused by insufficient cooling water will result in engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

20. Provide cooling water to the engine.
21. Start engine.
22. Check hose connections, gaskets, and seals for leaks.
23. Inspect fuel line connections for fuel leaks.

Hydraulic Valve Lifters

Exploded View



72031

Valve lifter

1 - Pushrod seat retainer clip
2 - Pushrod seat
3 - Metering valve
4 - Plunger
5 - Check ball
6 - Check ball spring
7 - Check ball retainer
8 - Plunger spring
9 - Lifter body
10 - Roller

Special Information

Hydraulic valve lifters require little attention. These lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.

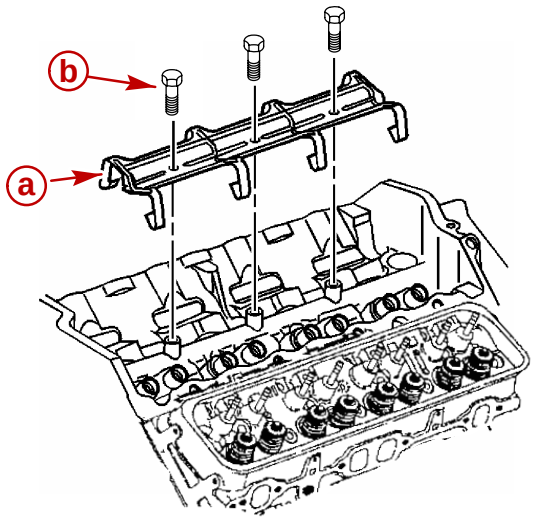
Refer to **Section 1C** for troubleshooting information such as locating a noisy lifter.

Removal

1. Drain seawater and closed cooling systems.
2. Remove valve covers.

IMPORTANT: Keep rocker arm assembly, valve pushrod, and hydraulic valve lifter from each valve together as a matched set. Mark and organize parts so that they can be installed in the same location later.

3. Remove rocker arm assemblies and valve pushrods. Keep parts in matched sets.
4. Remove intake manifold.
5. Remove lifter guide retainer.

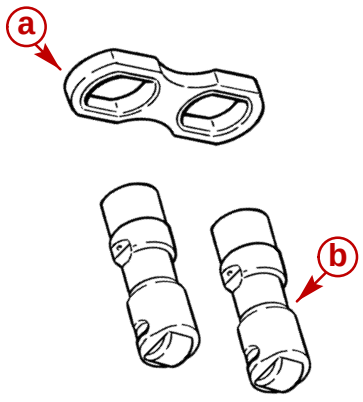


77872

a - Lifter guide retainer
b - Bolts

IMPORTANT: Store the valve lifters in the upright position to prevent oil loss.

6. Remove lifter guides and valve lifters. Store lifters in the upright position in order of removal.



72340

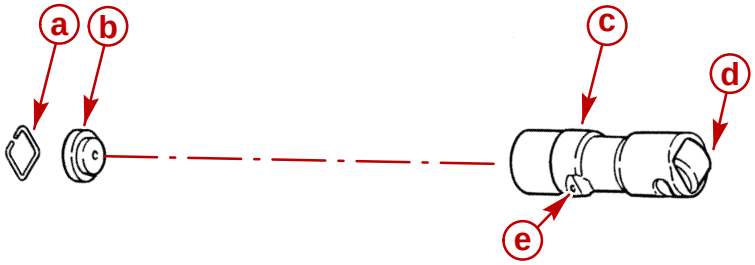
a - Lifter guide
b - Valve lifter

Cleaning

1. Except for the valve lifters, clean the parts with cleaning solvent.
2. Dry parts with compressed air.
3. While holding upright, wipe the valve lifters with a clean, oil saturated, lint free cloth. Store valve lifters in the upright position..

Inspection

1. Ensure that the lifter seat retainer clip is not broken or damaged.
2. Inspect pushrod seat. If seat is scuffed or worn, inspect pushrod.
3. Inspect outer lifter body wall. If wall is scuffed or worn, inspect engine block lifter bore.
4. Inspect the roller of valve lifter. If roller is scuffed or worn, inspect camshaft lobe.
5. Ensure oil hole is unobstructed.
6. Inspect all parts carefully. If any are damaged or worn, the entire lifter assembly should be replaced.



72031

Inspection of lifter

a - Seat retainer clip
b - Pushrod seat
c - Valve lifter body
d - Roller
e - Oil hole

Installation

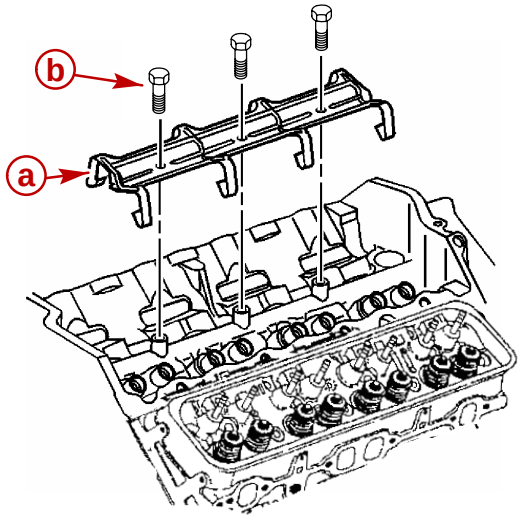
IMPORTANT: Do not install used valve lifters if a new camshaft has been installed.

IMPORTANT: Before installing valve lifters, coat the camshaft lobes and valve lifters with Johnson Engine Prelube.

1. Lubricate and install valve lifters. Install valve lifters in original locations if being reused.

Description	Where Used	Part Number
Johnson Engine Prelube	Valve lifters, camshafts and camshafts lobes	92-801779

2. Install lifter guides.
3. Install lifter guide retainer. Torque bolts.



77872

a - Lifter guide retainer
b - Bolts

Description	Nm	lb-in.	lb-ft
Valve lifter guide retainer bolt	25		19

4. Lubricate and install valve pushrods and rocker arm assemblies.

Description	Where Used	Part Number
Engine Oil	Valve pushrods and rocker arm assemblies	Obtain locally

5. Adjust valve clearance.
6. Install intake manifold.
7. Install valve covers.
8. Change engine oil and filter.
9. Refill closed cooling system, if equipped.
10. Check for leaks when engine is started.

Camshaft and Camshaft Bearings

IMPORTANT: Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Disconnect and fasten connecting rods against sides of engine so that they will not interfere while replacing camshaft bearings.

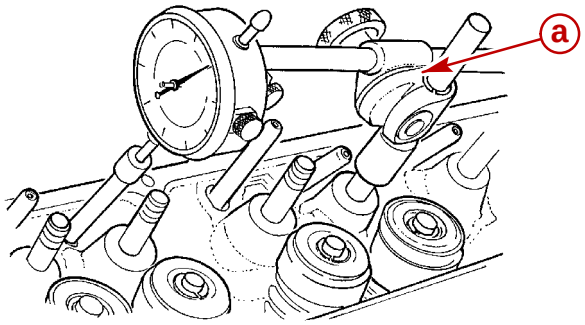
Measuring Camshaft Lobe Lift

NOTE:*Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each valve pushrod in consecutive order and record readings.*

1. Remove valve covers.

IMPORTANT: Keep rocker arm assembly from each valve together as a matched set. Mark and organize parts so that they can be installed in the same location later.

2. Remove rocker arm assemblies. Keep in matched sets.
3. Position dial indicator with Ball Socket Adapter Tool on valve pushrod. Ensure that valve pushrod is in lifter socket.



72380

a - Ball Socket Adapter Tool

Description	Part Number
Ball Socket Adapter Tool	J8520-1

4. Rotate crankshaft balancer slowly in direction of engine rotation until lifter is on the heel of the cam shaft lobe. At this point, the valve pushrod will be in its lowest position.
5. Set dial indicator on 0, then rotate crankshaft balancer slowly until valve pushrod is in fully raised position.
6. Compare total lift recorded from dial indicator to specification.

Description		**5.0 liter (305 CID) / 5.7 liter (350 CID)**
Valve lift	Intake	6.97-7.07 mm (0.2744-0.2783 in.)
	Exhaust	7.20-7.30 mm (0.2834-0.2874 in.)

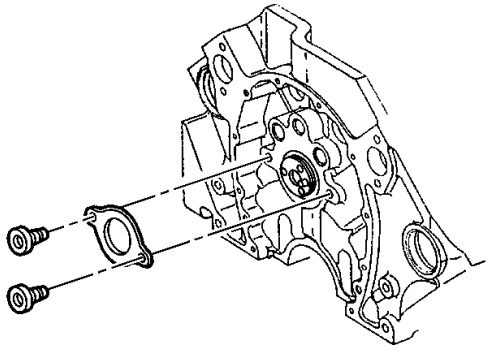
Description		**6.2 liter (377 CID)**
Valve lift	Intake	7.90-8.00 mm (0.3114-0.3153 in.)
	Exhaust	8.00-8.10 mm (0.3160-0.3200 in.)

7. Continue to rotate engine until dial indicator reads 0. This will ensure accuracy of original reading.
8. Replace the camshaft if valve lift is not within specifications.
9. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
10. Install rocker arm assemblies.
11. Adjust valve clearance.
12. Install valve covers.
13. Check for leaks when engine is started.

Removal

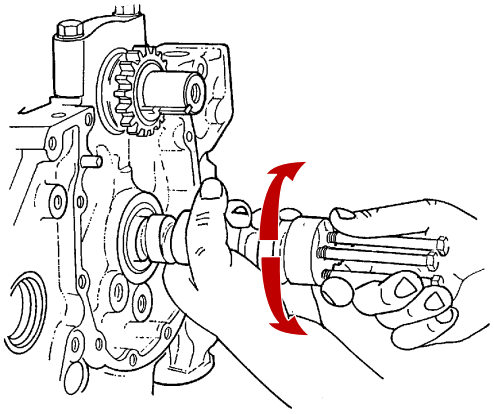
CAMSHAFT

1. Remove all components from the front of the engine.
2. Remove valve lifters.
3. Remove crankcase front cover.
4. Remove camshaft sprocket and timing chain.
5. Remove camshaft thrust plate.



77873

6. Install three 5/16-18 x 5 in. (127 mm) long bolts in camshaft bolt holes.
7. Carefully rotate and remove camshaft as shown.



72381

Removing camshaft

BEARINGS

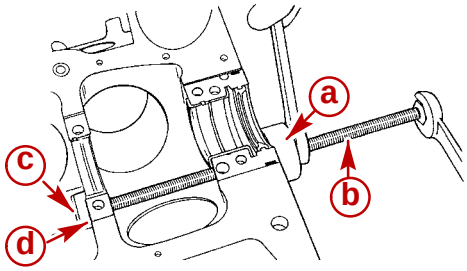
1. With camshaft and crankshaft removed, drive camshaft rear plug from engine block.

NOTE:*This procedure is based on removal of bearings from center of engine first, thus requiring a minimum amount of effort to remove all bearings.*

2. Install nut and thrust washer to the end of the threads on the Camshaft Bearing Remover And Installer.

Description	Part Number
Camshaft Bearing Remover And Installer	J6098–10

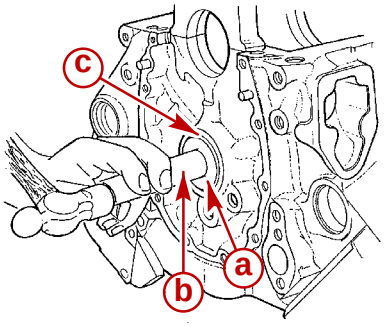
3. Position index pilot in front camshaft bearing.
4. Install puller screw through the index pilot.
5. Install driver with shoulder toward bearing. Ensure that a sufficient amount of threads are engaged.
6. Use one wrench to hold puller screw, while turning nut with second wrench.
7. Pull bearing from bore.
8. Remove tool and bearing from puller screw.
9. Remove remaining bearings, except front and rear bearings, in a similar manner.
10. Position index pilot in rear camshaft bearing to remove rear intermediate bearing.



72383

a - Index pilot
b - Puller screw
c - Driver
d - Bearing

11. Assemble the driver onto the driver handle of the Camshaft Bearing Remover And Installer. Drive the front and rear camshaft bearings toward center of engine block, and remove the bearings.



72384

a - Driver
b - Driver handle
c - Bearing

Description	Part Number
Camshaft Bearing Remover And Installer	J6098–10

Cleaning

CAMSHAFT

1. Clean camshaft thrust plate with cleaning solvent.
2. Clean camshaft with cleaning solvent
3. Dry parts with compressed air.

BEARINGS

1. Clean bearings in cleaning solvent.
2. Clean camshaft bearing bores in engine block with solvent
3. Ensure that grooves and drilled oil passages are clean.
4. Clean bores and passages with compressed air.
5. Dry parts with compressed air.

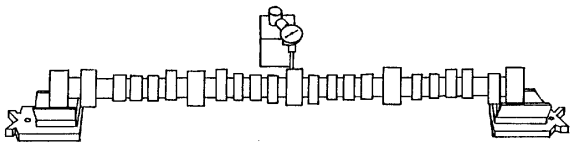
Inspection

CAMSHAFT

1. Inspect camshaft thrust plate for damage. Replace if damaged or worn.
2. Inspect the camshaft for worn, scored or damaged bearing journals or lobes.
3. Inspect the camshaft for bolt hole threads.
4. Inspect the camshaft sprocket locator pin.
5. Measure camshaft bearing journals with a micrometer. If journals are not within specifications, camshaft should be replaced.

Description	5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Journal diameter	47.440-47.490 mm (1.8677-1.8697 in.)
Journal out of round	0.025 mm (0.0010 in.) maximum

6. Measure for a bent camshaft or excessive camshaft runout with V-blocks and dial indicator. If runout exceeds specified amount, camshaft should be replaced.



72382

Checking camshaft runout

Description	5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Camshaft runout	0.065 mm (0.0026 in.) maximum

BEARINGS

1. Inspect camshaft bearings for excessive wear or scoring. If any camshaft bearing is excessively worn or scored, replace all the camshaft bearings.
2. Inspect the camshaft bearings for correct fit into the engine block camshaft bearing bores. The camshaft bearings have an interference fit to the engine block camshaft bearing bores and must not be loose in the bores.

Installation

BEARINGS

IMPORTANT: Front and rear bearings must be installed last as index pilot will not fit into bearing bores if front and rear bearings are installed.

1. Lubricate outer surface of new camshaft bearings with lubricant to ease installation.

Description	Where Used	Part Number
Engine Oil	Camshaft bearings	Obtain locally

IMPORTANT: All camshaft bearings are not the same. Install bearings in proper locations (Indicated by bearing manufacturer) and positioned correctly.

2. Before installation, ensure that camshaft bearings are positioned (indexed) as indicated:
   a. Position the front bearing so that the oil holes are an equal distance from the 6 o'clock position in the engine block.
   b. Position the intermediate and center bearings so that the oil holes are at the 5 o'clock position (toward left side of engine block and at a position even with bottom of cylinder bore).
   c. Position the rear bearing so that the oil hole is at the 12 o'clock position.
3. Install intermediate and center camshaft bearings using the Camshaft Bearing Remover And Installer Tool.

Description	Part Number
Camshaft Bearing Remover And Installer	J6098–10

   a. Install nut and thrust washer onto puller screw.
   b. Position pilot in front camshaft bearing bore and insert screw through pilot.
   c. Index center camshaft bearing.
   d. Position appropriate size Removal And Installation Tool in bearing and thread puller screw into tool. Ensure that at least 13 mm (1/2 in.) of threads are engaged.
   e. Using 2 wrenches, hold puller screw and turn nut until bearing has been pulled into position.
   f. Remove the Removal And Installation Tool and ensure that oil holes in bearing are positioned correctly.
   g. Repeat steps a. – f. to install the intermediate bearings. Ensure that the bearings are indexed correctly.
   h. Position pilot in rear camshaft bearing bore to install rear intermediate bearing.

4. Install the front and rear camshaft bearings using the Camshaft Bearing Remover And Installer Tool.

Description	Part Number
Camshaft Bearing Remover And Installer	J6098–10

a. Install appropriate size Removal And Installation Tool on drive handle.

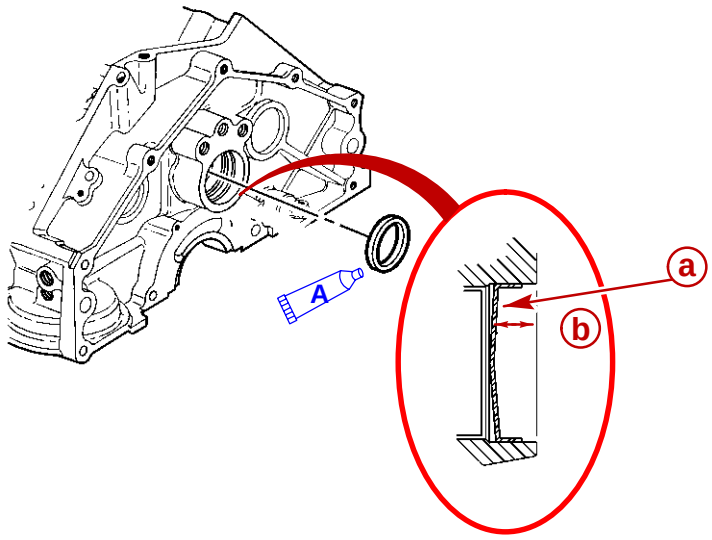
b. Index front bearing and drive it into position with tool.

c. Index rear bearing and drive it into position with tool.

d. Ensure bearings are positioned correctly.

IMPORTANT: Camshaft rear bearing hole plug must be installed 8.8 mm (0.3465 in.) deep and must be parallel with rear surface of engine block.

e. Coat outer diameter of a new camshaft rear bearing hole expansion cup plug with sealant and install the plug.



77893

a - Camshaft rear bearing hole expansion cup plug
b - Measurement - 8.8 mm (0.3465 in.)

Description		Where Used	Part Number
A	Loctite 565 PST	Camshaft rear bearing hole expansion cup plug	Obtain locally

CAMSHAFT

1. Install three 5/16-18 x 5 in. bolts in camshaft bolt holes.
2. Lubricate camshaft journals with engine oil and install camshaft. Do not damage bearings.

Description	Where Used	Part Number
Engine Oil	Camshaft journals	Obtain locally

3. Lubricate camshaft lobes with Engine Prelube.

Description	Where Used	Part Number
Johnson Engine Prelube	Camshafts lobes	92-801779

4. Remove the 3 bolts in camshaft bolt holes.
5. Coat threads of camshaft thrust plate retainer bolts with sealant.

Description	Where Used	Part Number
Loctite 242 Threadlocker	Camshaft thrust plate retainer bolt	92-809821

6. Install camshaft thrust plate retainer and bolts. Torque bolts.

Description	Nm	lb-in.	lb-ft
Camshaft thrust plate retainer bolt	12	106	

7. Install camshaft sprocket and timing chain.

IMPORTANT: Crankcase front cover is not reusable per manufacturer's specification. It must be replaced if removed.

8. Install new crankcase front cover and gasket.
9. Install valve lifters.
10. Install rocker arm assemblies.
11. Adjust valve clearance.
12. Install valve covers.

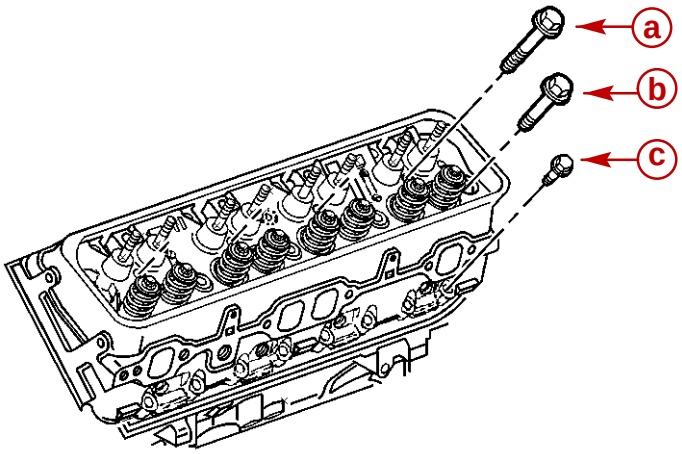
Cylinder Head

Removal

1. Drain seawater and closed cooling systems.
2. Remove exhaust elbows and manifolds.
3. Remove valve covers.
4. Remove intake manifold assembly.

IMPORTANT: Keep rocker arm assembly, valve pushrod, and hydraulic valve lifter from each valve together as a matched set. Mark and organize parts so that they can be reinstalled in the same location later.

5. Remove rocker arm assemblies and valve pushrods. Keep in matched sets.
6. Remove any components attached to the cylinder head.
7. Remove spark plugs.
8. Remove cylinder head bolts.



77878

a - Long bolts
b - Medium bolts
c - Short bolts

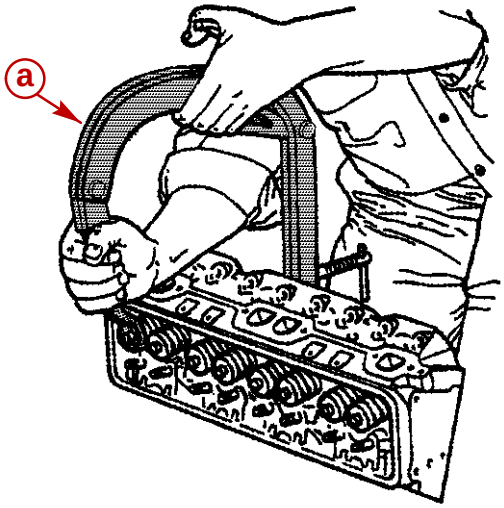
⚠ CAUTION

The head gasket may be holding cylinder head to block. Use care when prying off cylinder heads. Do not damage gasket surfaces. Do not drop cylinder heads.

9. Remove cylinder head.
10. Place cylinder head on wooden blocks to prevent damage to gasket surfaces.

Disassembly

1. Using Valve Lifter Tool, compress valve spring and remove valve locks. Slowly release tool.



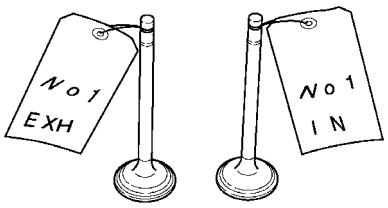
77883

a - Valve Lifter Tool

Description	Part Number
Valve Lifter Tool	J8062

IMPORTANT: Keep components together as a matched set. Mark and organize parts so that they can be reinstalled in the same location later.

2. Remove valve spring cap and spring.
3. Remove valves from cylinder head.
4. Mark and organize components for installation in the same location later.



77175

5. Remove and discard valve oil seals.
6. Place cylinder head on wooden blocks to prevent damage to gasket surfaces.

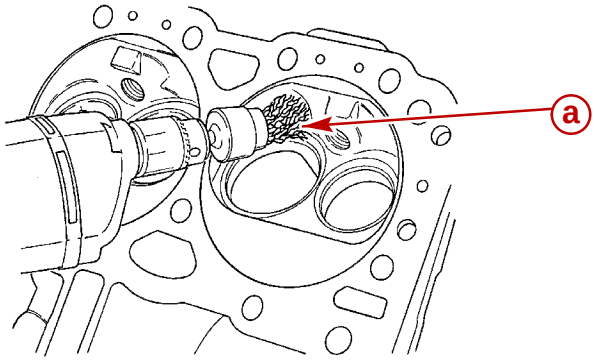
Cleaning

VALVE COMPONENTS

1. Clean the valve locks, valve spring caps, and valve springs in cleaning solvent.
2. Clean carbon from valves using a wire wheel.
3. Clean the valves in cleaning solvent.
4. Dry parts with compressed air.

CYLINDER HEAD

1. Clean gasket material and sealant from engine block and cylinder head sealing surfaces.
2. Clean all carbon from combustion chambers and valve ports using carbon cleaning brush.

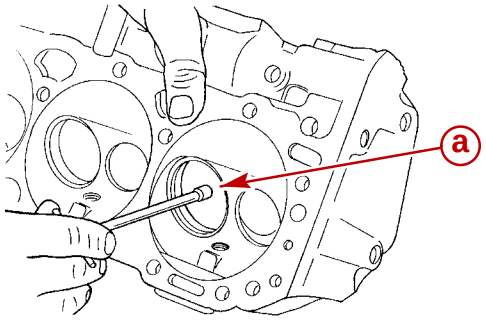


72334

a - Carbon Cleaning Brush

Description	Part Number
Carbon Cleaning Brush	J8089

3. Thoroughly clean valve guides with Valve Guide Cleaner.



72335

a - Valve Guide Cleaner

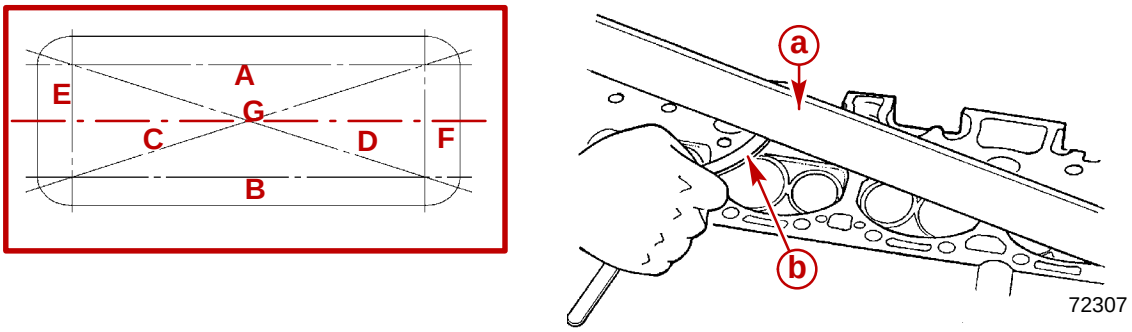
Description	Part Number
Valve Guide Cleaner	J8101

4. Clean and dry the cylinder head.
   a. Clean cylinder head bolt threads and engine block bolt hole threads to ensure that no dirt, old oil, or coolant remain.
   b. Dry all parts with compressed air, including cylinder head bolt threads and engine block bolt hole threads.

Inspection

CYLINDER HEAD

1. Inspect sealing surfaces for burrs, scratches, deep nicks, erosion, or other damage.
2. Inspect for cracks in exhaust ports, water jackets, and combustion chambers (especially around spark plug holes and valve seats).
3. Replace cylinder heads if necessary.
4. Inspect for rusted, damaged, or leaking core plugs. Replace core plugs if necessary.
5. Inspect for corrosion around cooling passages.
6. Check flatness of cylinder head gasket surfaces using a machinist's straight edge and feeler gauges. Take measurements diagonally "C and D" across cylinder head both ways "A, B, E, F", and straight down center of cylinder head "G".



Measuring engine block deck surface flatness – all models similarly measured

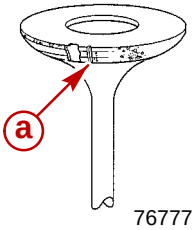
a - Straightedge
b - Feeler gauge

Description		**5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)**
Surface flatness	At exhaust manifold deck	0.05 mm (0.002 in.)
	At engine block deck - within a 152 mm (6.0 in.) area	0.10 mm (0.004 in.)
	At intake manifold deck	0.10 mm (0.004 in.)

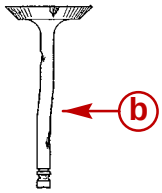
7. If measured value is greater than specified, the cylinder head must be repaired or replaced to provide proper alignment.

VALVE

1. Inspect valves for burned heads, cracked or pitted faces, or damaged stems.



76777

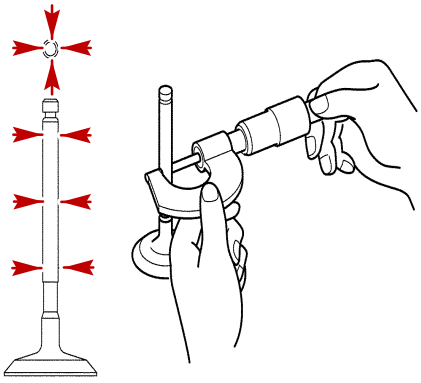


76776

a - Cracked, pitted face
b - Damaged stems

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possibly broken valves. Insufficient clearance will result in noisy, binding valves.

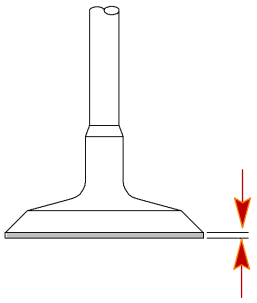
2. Measure valve stem diameter in 3 places.
3. If the measured value is less than specified limit, the valve must be replaced.



77196

Description		**5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)**
Production stem diameter	Intake	8.661-8.679 mm (0.3410-0.3417 in.)
	Exhaust	
Service stem oversize diameter	Exhaust only	+ 0.774 mm (+ 0.0305 in.)

4. Measure valve head margin.
5. If the measured value is less than specified limit, the valve must be replaced.

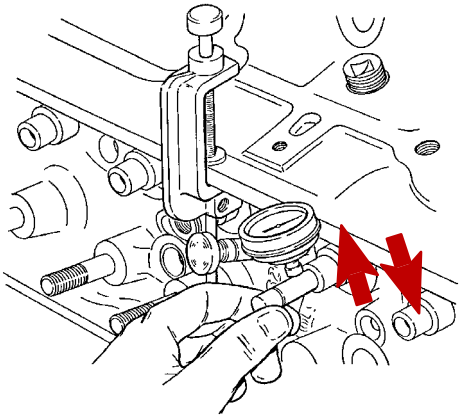


77197

Description		5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Margin after surfacing	Intake	0.79 mm (0.031 in.) Minimum
	Exhaust	1.524-2.032 mm (0.060-0.080 in.)

VALVE STEM TO BORE CLEARANCE

1. Using a valve with specified stem diameter or a new valve, measure valve stem clearance.
   a. Attach a dial indicator to cylinder head. Position it against the valve stem and close to the valve guide.
   b. Holding valve head off the seat about 2 mm (1/16 in.), move valve stem side to side in the guide. Compare stem clearance with specifications.



72336

Measuring stem clearance

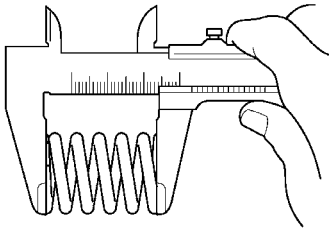
Description		5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Production	Intake	0.025-0.069 mm (0.0010-0.0027 in.)
	Exhaust	0.025-0.069 mm (0.0010-0.0027 in.)
Service	Intake	0.025-0.094 mm (0.0010-0.0037 in.)
	Exhaust	0.025-0.094 mm (0.0010-0.0037 in.)

c. **If clearance exceeds specifications on exhaust valve and exhaust guide,** it will be necessary to ream valve guide and install a valve with an oversized stem. Refer to Repair - Valve Guide Bore.

d. **If clearance exceeds specifications on intake valve and intake guide,** it will be necessary to replace the cylinder head. Intake valves are not available with oversize stems.

VALVE SPRINGS

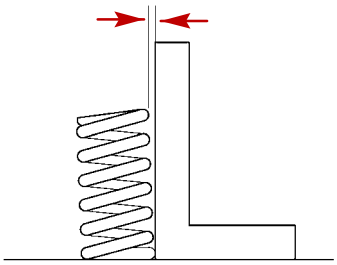
1. Use a vernier caliper to measure the valve spring free length. Replace spring if it is more or less than specified limit.



77198

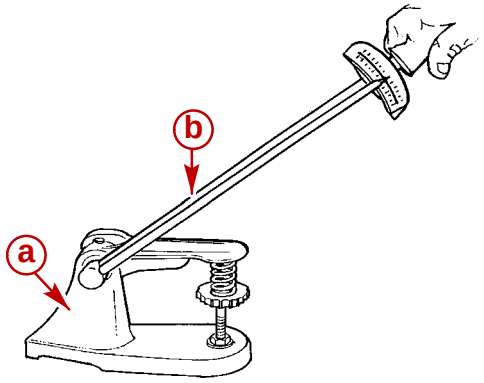
Description	5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Free length	51.3 mm (2.02 in.)

2. Measure the valve for squareness.



77199

3. Use the Valve Spring Tester to measure the valve spring tension. Replace spring if measured value is less than specified limit.



72308

a - Valve Spring Tester
b - Torque wrench

Description	Part Number
Valve Spring Tester	J9666

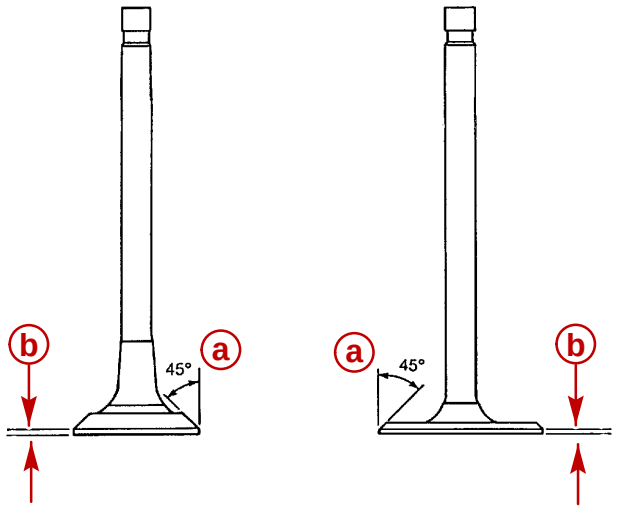
Description		5.0 liter (305 CID) / 5.7 liter (350 ID) / 6.2 liter (377 CID)
Pressure	Valve closed	338-374 N (76-84 lb) at 43.2 mm (1.7 in)
	Valve open	832-903 N (187-203 lb) at 32.3 mm (1.27 in)

Repair

VALVE RECONDITIONING

1. Recondition valve face to the proper angle if valve face is pitted or worn.
2. Measure valve margin. If valve margin is less than specified after reconditioning, replace the valve.

NOTE:*Several different types of equipment are available for reconditioning valves. The manufacturer's recommendation should be carefully followed to attain proper results.*



Exhaust **Intake**

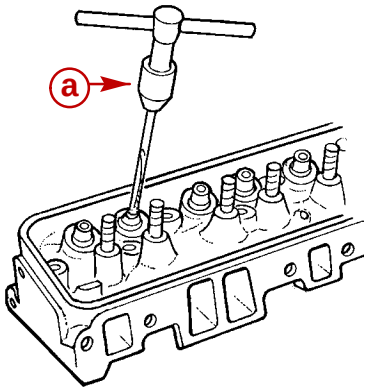
a - Face angle
b - Margin

Description		**5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)**
Face angle	Intake	45 degrees
	Exhaust	
Margin after surfacing	Intake	0.79 mm (0.031 in.) minimum
	Exhaust	1.524-2.032 mm (0.060-0.080 in.)

VALVE GUIDE BORE

IMPORTANT: Measure valve stem diameter of both the intake and exhaust valve; valve stem diameter may or may not be the same for both valves.

1. If exhaust valves with oversize valve stems are required, ream valve guide bores.



72337

a - Valve Guide Reamer

Description	Part Number
Valve Guide Reamer (0.015 in. oversize)	J5830-02

Description		5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Production stem diameter	Intake	8.661-8.679 mm (0.3410-0.3417 in.)
	Exhaust	
Service stem oversize diameter	Exhaust only	+ 0.774 mm (+ 0.0305 in.)

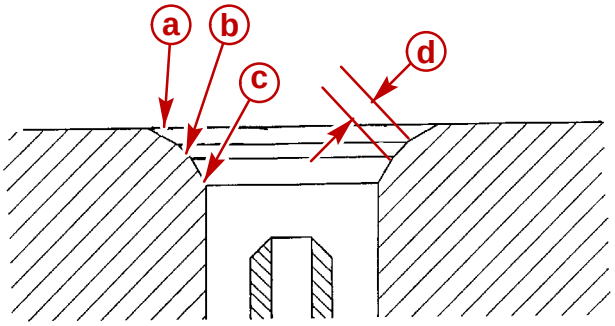
2. Remove the sharp corner created by reamer at top of valve guide.
3. Install valve with oversized stem.
4. Measure valve stem to bore clearance.

VALVE SEAT

IMPORTANT: Regardless of the type of equipment used to recondition the valve seats, it is essential that valve guide bores be free from carbon or dirt to achieve proper centering of pilot in valve guide ensuring concentricity when reconditioning valve seats.

NOTE:*Several different types of equipment are available for reconditioning valves. The manufacturer's recommendations should be carefully followed to attain proper results.*

1. Recondition valve seats if pitted or worn.



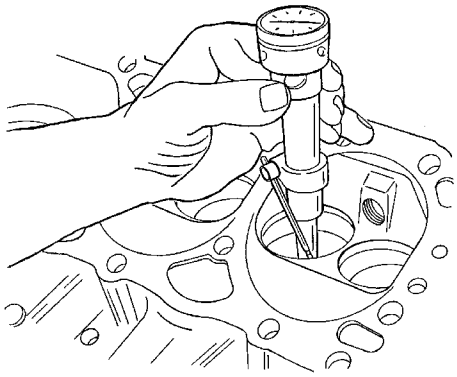
50668

Typical 3 angle valve seat

a - Top correction cut angle
b - Seat angle
c - Bottom correction cut angle
d - Seat width

Description		**5.0 liter (305 CID)**	**5.7 liter (350 CID) / 6.2 liter (377 CID)**
Seat angle	Intake and exhaust	46 degrees	
Top correction cut angle		30 degrees	
Bottom correction cut angle		60 degrees	
Width	Intake	1.14-1.78 mm (0.045-0.070 in.)	1.02-1.65 mm (0.040-0.065 in.)
	Exhaust	1.65-2.49 mm (0.065-0.098 in.)	1.50-2.56 mm (0.059-0.101 in.)

2. Measure valve seat concentricity.
3. Recondition the valve seat if measured value exceeds specified limit.



72338

Measuring valve seat concentricity

Description		5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Runout	Intake	0.05 mm (0.0020 in.) maximum
	Exhaust	

ROCKER ARM STUD REPLACEMENT

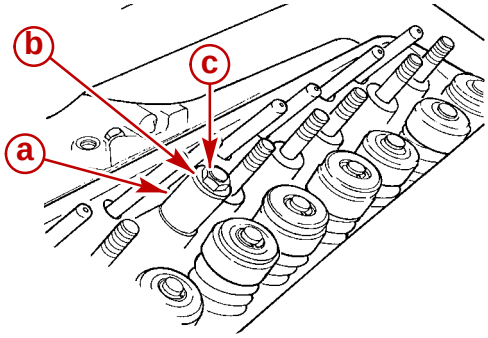
IMPORTANT: Replace worn or loose valve rocker arm studs with oversize studs. The studs are pressed into the cylinder head.

Two replacement valve rocker arm ball studs sizes are available:

Description	5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
First oversize	+ 0.003 in.
Second oversize	+ 0.013 in.

1. Place Rocker Arm Stud Remover and flat washer over stud.

2. Install a 3/8 in.-24 threaded nut.
3. Turn nut clockwise to remove stud.



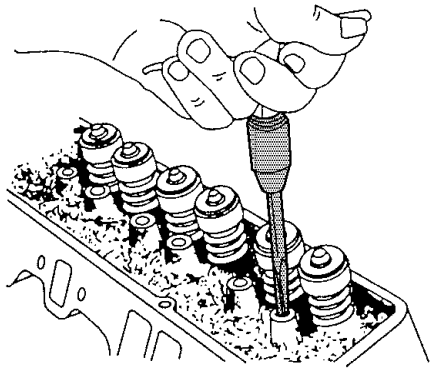
72309

a - Rocker Arm Stud Remover
b - Flat washer
c - Nut

Description	Part Number
Rocker Arm Stud Remover	J5802-01

IMPORTANT: Rocker arm stud hole must be reamed with appropriate tool to accept an oversize replacement stud.

4. Ream rocker arm stud hole using appropriate reaming tool.



77864

Reaming rocker arm stud hole

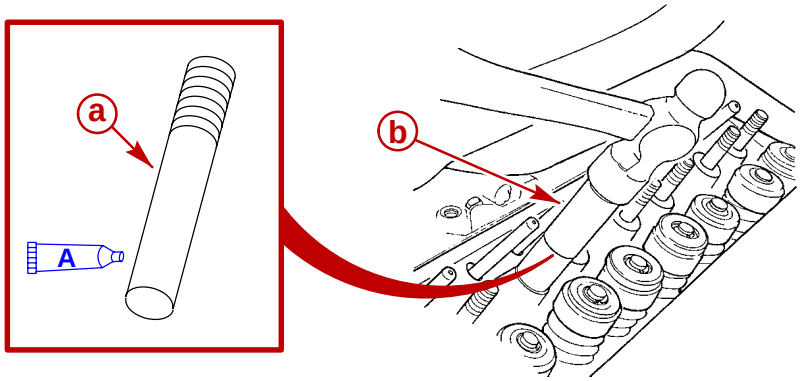
Description	Part Number
Stud Bore Reamer Tool (0.003 in. first oversize)	J5715
Stud Bore Reamer Tool (0.013 in. oversize)	J6036

5. Coat the end of the oversize rocker arm stud with lubricant.

Description	Where Used	Part Number
80W Gear Lube	Rocker arm stud	Obtain locally

6. Install oversize stud with Rocker Arm Stud Installer.

NOTE:*When using the rocker arm stud installer the installation depth is correct when tool contacts the cylinder head.*



72311

a - Oversize rocker arm stud
b - Rocker Arm Stud Installer

Description	Part Number
Rocker Arm Stud Installer	J6880

Description		Where Used	Part Number
A	80W Gear Lube	Rocker arm stud	Obtain locally

Reassembly

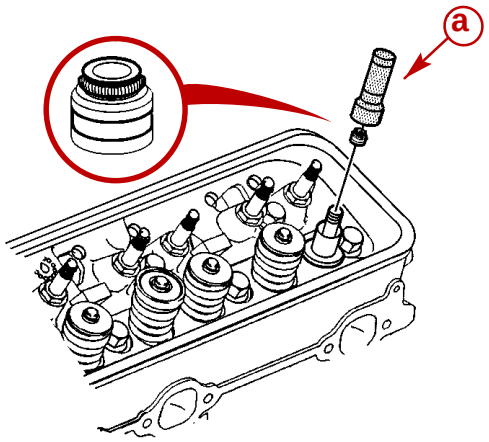
IMPORTANT: Install each valve in the port from which it was removed or for which it has been fitted.

IMPORTANT: The intake valve stem oil seal material is black. The exhaust valve stem oil seal material is either brown with a white paint stripe on the outer diameter or it is red with no paint stripe. Also, the letters "EX" are molded into the top of the exhaust valve stem oil seal.

1. Select the appropriate intake or exhaust valve stem oil seal.
2. Coat the outside surface of the valve stem bore and all surfaces of the valve stem oil seal with clean engine oil.

Description	Where Used	Part Number
Engine Oil	Valve stem bore and valve stem oil seal	Obtain locally

3. Install the valve stem oil seal onto the valve stem and push down until it is seated against the cylinder head.
4. Install Valve Stem Seal Installer and press the valve stem oil seal until the tool contacts the spring seat.



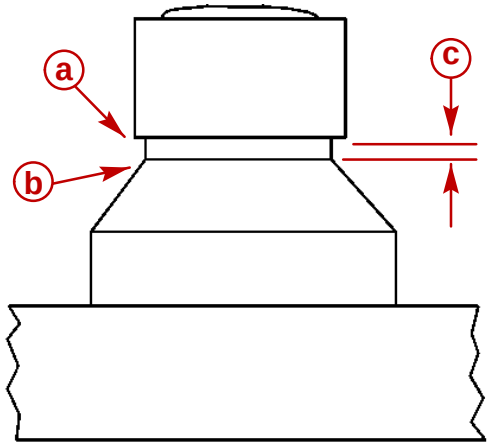
77867

Typical

a - Valve Stem Seal Installer

Description	Part Number
Valve Stem Seal Installer	J42073

5. For all intake and exhaust valves, ensure that the installed height (the gap between the bottom edge of the valve stem oil seal and the cylinder head valve guide boss) is as specified.



77868

a - Bottom of valve stem oil seal
b - Valve guide boss
c - Installed height (gap)

Description		**5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)**
Valve stem oil seal	Installed height[1]	1-2 mm (0.0394-0.0787 in.)

[1] *Measured from the top of the valve guide boss to the bottom of the valve stem oil seal.*

6. Install valve spring.
7. Place valve spring cap on valve spring.

⚠ CAUTION

Improperly compressed valve springs or improperly locked valve spring caps could allow the spring to be ejected with tremendous force, which could cause personal injury. Use care when compressing the valve springs or releasing the valve spring compressor tool.

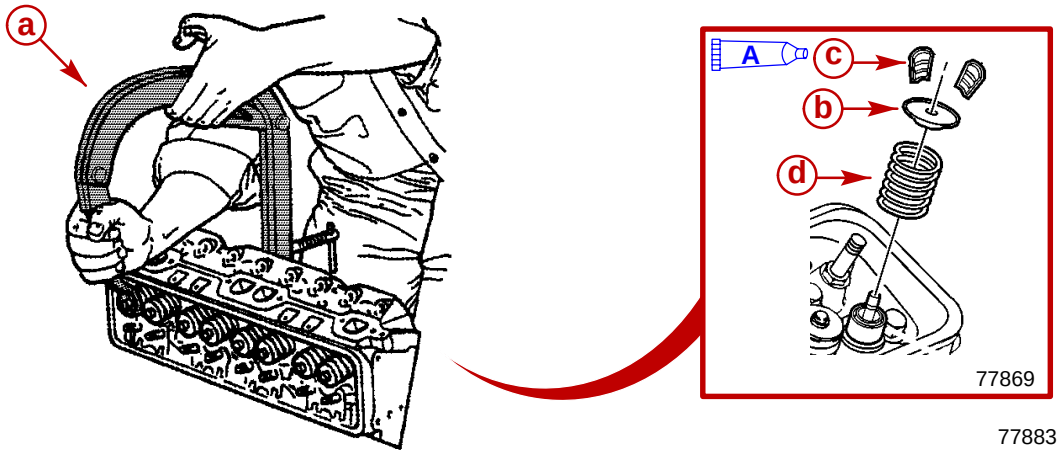
8. Compress the valve spring using a Valve Lifter Tool.

Description	Part Number
Valve Lifter Tool	J8062

9. Coat the valve stem locks with lubricant to hold in place.

Description	Where Used	Part Number
Needle Bearing Assembly Lubricant	Valve stem locks	92-082868A1

10. Install the valve stem locks.
11. Ensure valve stem locks are seated properly in the groove of the valve stem.



a - Valve lifter tool
b - Cap
c - Valve locks
d - Spring

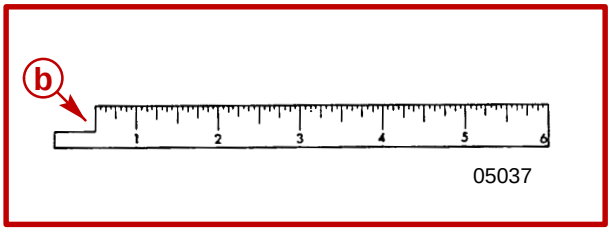
Description	Part Number
Valve Lifter Tool	J8062

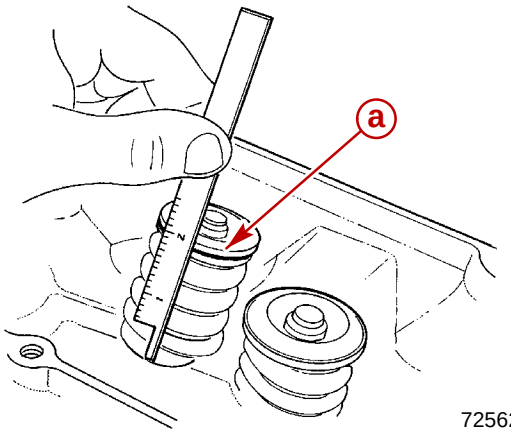
Description		Where Used	Part Number
A	Needle Bearing Assembly Lubricant	Valve stem locks	92-082868A1

12. Slowly release valve spring compressor.
13. Set assembly by tapping valve stem with a soft (plastic) hammer.

14. Check installed height of valve springs using a narrow, thin scale. Measure from spring seat to top of valve spring.

IMPORTANT: If measurement exceeds specified height, install a valve spring shim and recheck. Do not shim valve springs to give an installed height less than the minimum specified.





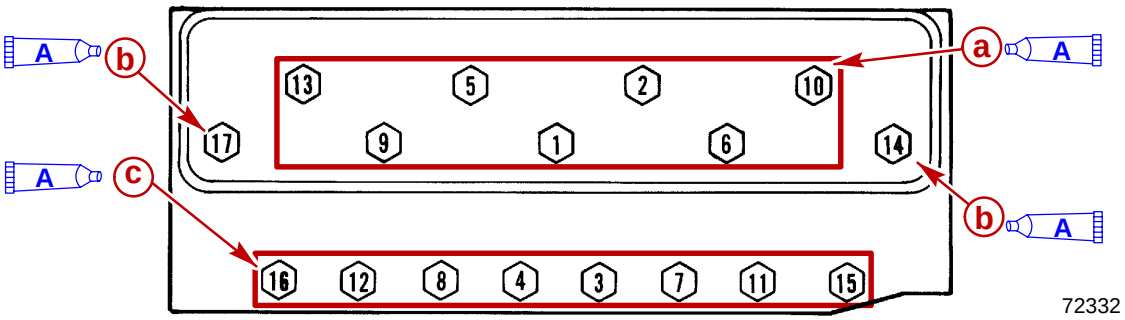
Typical

a - Valve spring installed height
b - Cut away scale

Description		**5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)**
Installed height	Intake	42.92-43.43 mm (1.6898-1.7098 in.)
	Exhaust	

Installation

1. Ensure the engine block and cylinder head sealing surfaces are clean.
2. Place a new head gasket in position over dowel pins.
3. Carefully set cylinder head in place over dowel pins.
4. Coat threads of cylinder head bolts with sealant and install bolts finger-tight.
5. Torque cylinder head bolts in passes using numbered sequence shown.



Cylinder head torque sequence

a - Long bolts (sequence numbers - 1, 2, 5, 6, 9, 10 and 13)
b - Medium bolts (14 and 17)
c - Short bolts (3, 4, 7, 8, 11, 12, 15 and 16)

Description		Where Used	Part Number
A	Loctite 565 PST	Cylinder head bolts	Obtain locally

Description			Nm	lb-in.	lb-ft
Cylinder head bolt - preferred method					
All bolts in sequence	First pass		30		22
In sequence angle torque	Final pass	Long bolts	+ 75 degrees		
		Medium bolts	+ 65 degrees		
		Short bolts	+ 55 degrees		
Cylinder head bolt - optional method					
All bolts in sequence	First pass		35		26
	Second pass		60		44
	Final pass		90		66

IMPORTANT: Keep pushrods and rocker arm assemblies together as a matched set. Install parts in the same location.

6. Install pushrods and rocker arm assemblies in their original positions.

7. Install intake manifold assembly.
8. Install valve covers.
9. Install exhaust manifolds and elbows.
10. Install any components removed.
11. Refill closed cooling system.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

12. Provide sufficient water supply to water inlet holes.
13. Start engine.
14. Check for leaks.

Oil Pan

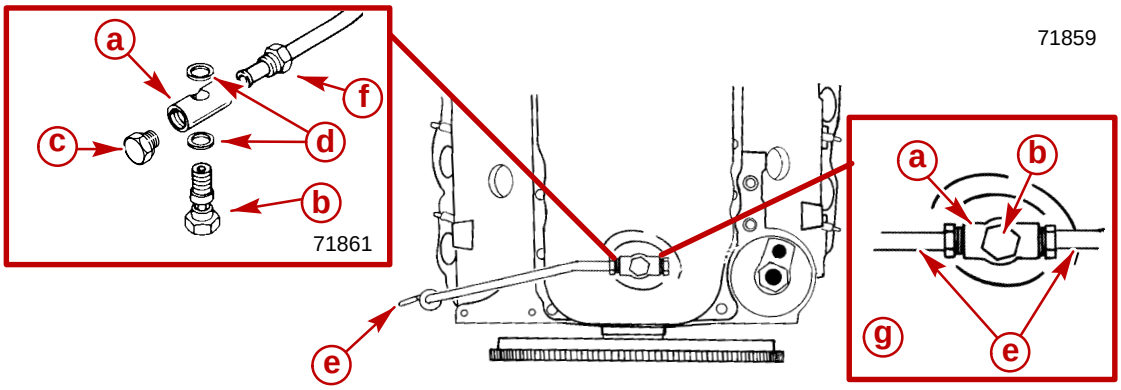
Removal

1. Drain engine oil from oil pan.

IMPORTANT: On MIE models be careful not to disturb the orientation of the oil pan fitting on bottom of pan.

2. **MIE models:** remove the dipstick and dipstick tube.

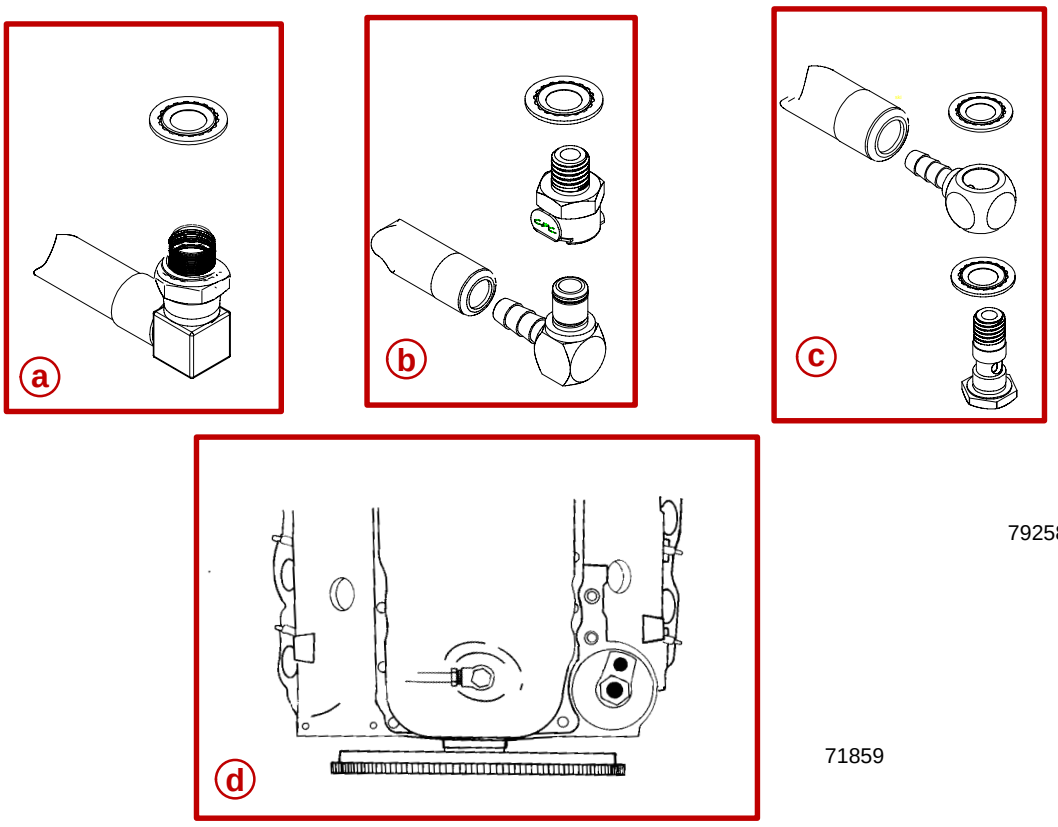
NOTE:*MIE models may be equipped with two dipstick tubes.*



Oil drain and dipstick tube connection for MIE models

- **a** - Hollow bolt fitting
- **b** - Hollow bolt
- **c** - Plug
- **d** - Sealing washer (2)
- **e** - Dipstick tube
- **f** - Sleeve nut
- **g** - Model with two dipstick tubes (plug not used)

3. If equipped, remove the quick oil drain connection assembly and sealing washer from the engine oil pan.



79258

71859

Quick oil drain connection styles

a - One piece assembly for MCM engines
b - Quick connect assembly for MCM engines
c - Hollow bolt assembly for Tow Sports engines
d - Quick oil drain assembly installed in oil pan

4. Remove oil pan.
5. Remove and discard the oil pan gasket.

Cleaning

1. Clean sealing surfaces of engine block and oil pan.
2. Clean oil pan in cleaning solvent.
3. Dry parts with compressed air.

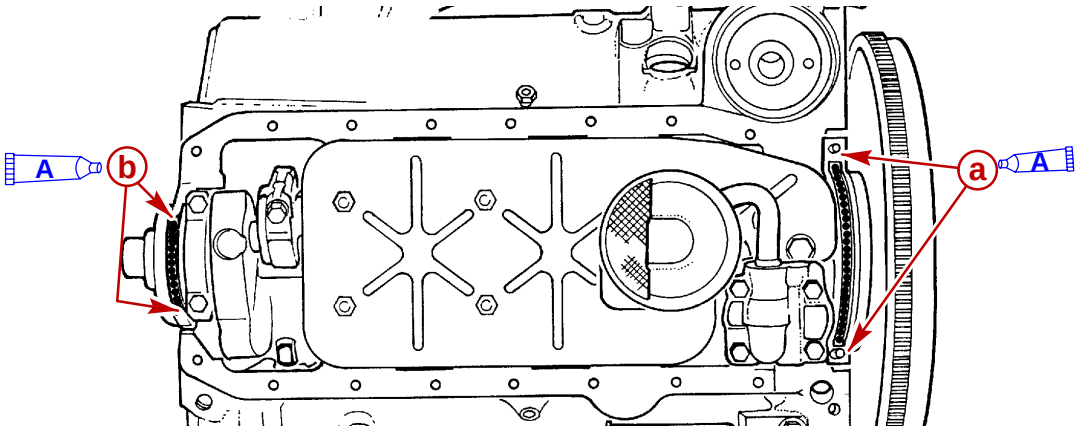
Inspection

1. Inspect oil pan for cracks, holes, warped sealing surfaces, or other damage.
2. Replace oil pan if necessary.

Installation

IMPORTANT: The adhesive sets up in about 15 minutes. Complete the assembly while adhesive is still wet.

1. Apply a 5 mm (13/64 in.) wide and 25 mm (1 in.) long bead of adhesive to both the right and left side joints of rear seal retainer and joints of front cover.



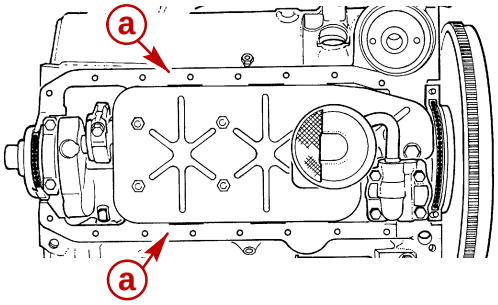
72343

a - Rear seal retainer joints
b - Front cover joints

Description		Where Used	Part Number
A	Loctite 5900 Ultra-Black RTV Silicone Sealant.	Engine block to the crankshaft rear oil seal housing junction at the oil pan sealing surfaces	92-809826
		Engine block to the engine front cover junction at the oil pan sealing surfaces	

IMPORTANT: Always install a new oil pan gasket.

2. Install a new oil pan gasket.



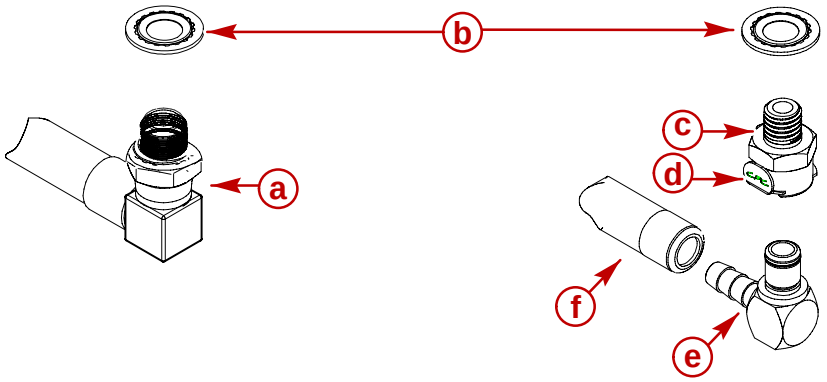
72343

a - Oil pan gasket

3. Install oil pan.
4. Ensure that the oil pan gasket is pressed into the grooves of the engine front cover and crankshaft rear oil seal housing.
5. Starting from the center and working outward in each direction, torque oil pan stud nuts and oil pan bolt or stud.

Description	Nm	lb-in.	lb-ft
Oil pan stud nut	25		18
Oil pan bolt or nut	12	106	

6. **On MCM models**, install the quick oil drain as follows:
   a. Assemble the sealing washer to the oil drain fitting.
   b. Hand start the oil drain fitting into the oil pan drain hole. Torque the oil drain fitting.



79374

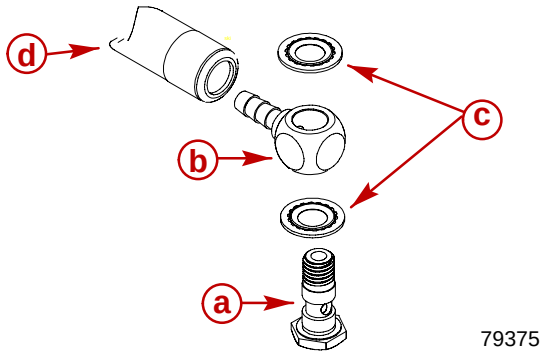
Quick oil drain connection styles for MCM models

a - Oil drain fitting for the one piece assembly
b - Sealing washer (2)
c - Oil drain fitting for the quick connect assembly
d - Release button
e - Quick connect fitting
f - Hose

Description	Nm	lb-in.	lb-ft
Oil drain fitting to oil pan	20	180	

   c. If equipped with the quick connect assembly, install the drain hose to the quick connect fitting and secure with hose clamp.
   d. Press the release button on the oil drain fitting (previously installed to oil pan) and insert the quick connect fitting until seated.

7. **On Tow Sports models**, install the quick oil drain as follows:
   a. Assemble the drain hose to the hollow bolt fitting. Secure with hose clamp.
   b. Assemble the sealing washer to the hollow bolt.
   c. Install the hollow bolt fitting to the hollow bolt.
   d. Assemble the sealing washer to the hollow bolt.
   e. Hand start the hollow bolt into the oil pan drain hole.
   f. Torque the oil drain fitting hollow bolt.



Quick oil drain connection for Tow Sports models

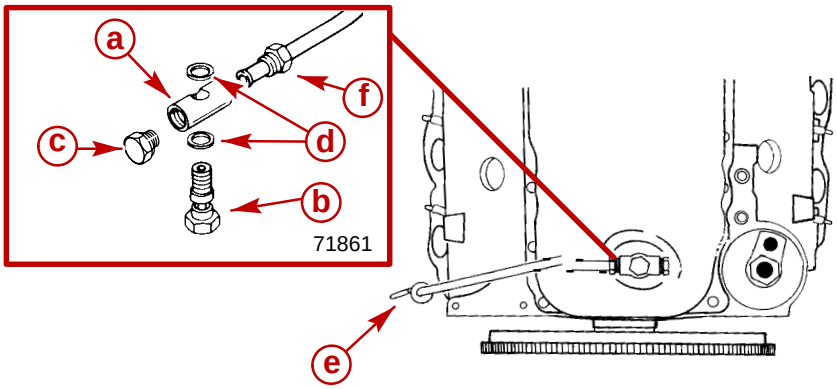
a - Hollow bolt
b - Hollow bolt fitting
c - Sealing washer (2)
d - Drain hose

Description	Nm	lb-in.	lb-ft
Oil drain fitting to oil pan	20	180	

8. **On MIE models,** install dipstick tube and dipstick as follows:
   a. Assemble the sealing washer to the hollow bolt.
   b. Install the hollow bolt fitting to the hollow bolt.
   c. Assemble the sealing washer to the hollow bolt.
   d. Hand start the hollow bolt into the oil pan drain hole. Temporarily finger-tighten.

NOTE:*Dipstick tube can be positioned on either side of engine.*

   e. Install dipstick tube and secure with hardware as shown. Temporarily finger-tighten the sleeve nut to the hollow bolt fitting.
   f. Secure dipstick tube with a J-clip and screw.
   g. Tighten sleeve nut in the hollow bolt fitting.
   h. If equipped with 2 dipstick tubes repeat steps e. - g.
   i. If equipped with 1 dipstick tube, Install the plug in the hollow bolt fitting. Securely tighten plug at fitting.
   j. Torque the oil drain fitting hollow bolt.



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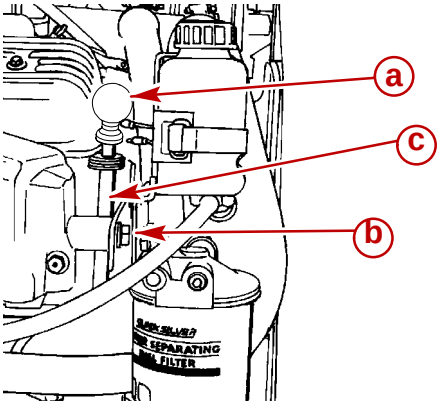
Oil drain and dipstick tube connection for MIE models

a - Hollow bolt fitting
b - Hollow bolt
c - Plug
d - Sealing washers (2)
e - Dipstick tube
f - Sleeve nut

Description	Nm	lb-in.	lb-ft
Oil pan drain fitting	20	180	

k. Install appropriate engine oil dipstick.



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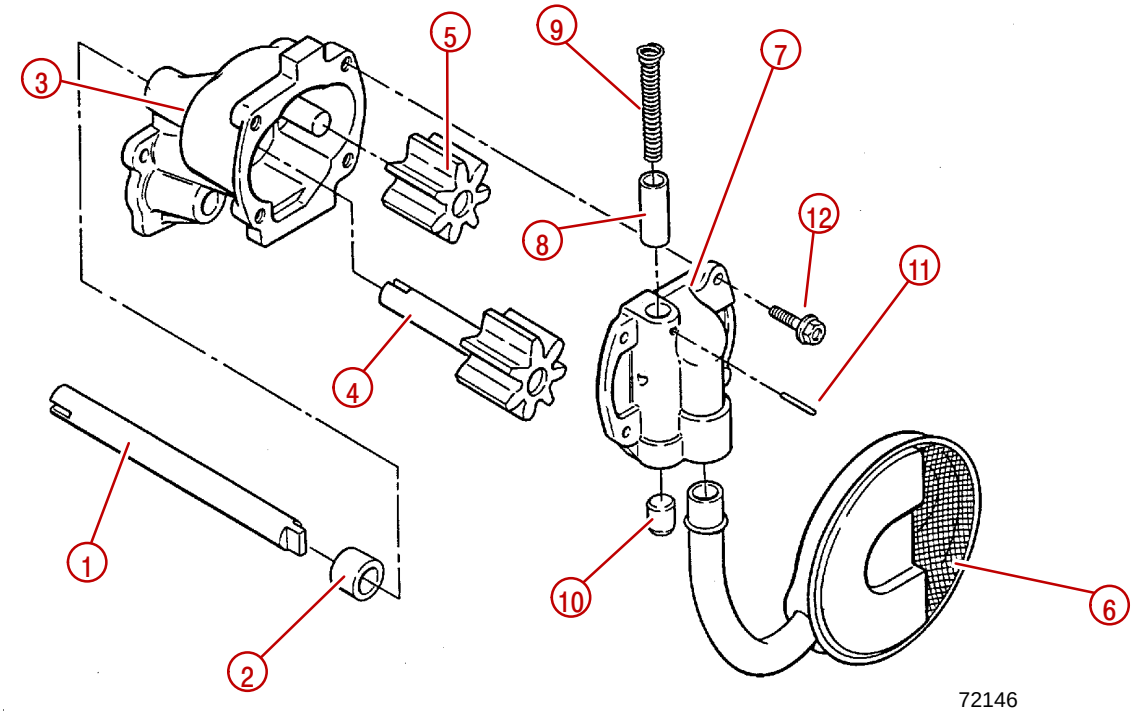
Typical

a - Dipstick
b - Clamp
c - Dipstick tube

9. Fill crankcase with specified engine oil.

Oil Pump

Exploded View

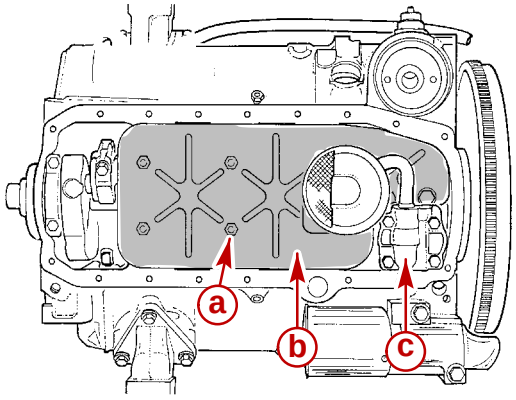


Oil pump assembly

- **a** - Drive shaft
- **b** - Drive shaft retainer
- **c** - Pump body
- **d** - Drive gear and shaft
- **e** - Idler gear
- **f** - Pick up screen and suction pipe
- **g** - Pump cover
- **h** - Pressure regulator valve
- **i** - Pressure regulator spring
- **j** - Plug
- **k** - Retaining pin
- **l** - Screw (4)

Removal

1. Drain engine oil from oil pan.
2. Remove oil pan.
3. Remove and discard the oil pan gasket.
4. Remove crankshaft oil deflector.



72344

a - Nuts (5)
b - Crankshaft oil deflector
c - Oil pump

5. Remove oil pump, driveshaft retainer, and driveshaft.

Disassembly

1. Remove pump cover.

IMPORTANT: Gear teeth must be marked for exact repositioning when reassembled.

2. Make alignment marks on the idler gear and drive gear teeth.
3. Remove idler gear and drive gear from pump body.

⚠ CAUTION

Pressure regulator valve spring is compressed. Use care when removing or installing retaining pin to prevent personal injury.

4. Remove retaining pin, spring, and pressure regulator valve from pump cover.

⚠ CAUTION

Do not remove suction pipe and pickup screen assembly unless replacement is necessary. Loss of press fit condition could result in an air leak and loss of oil pressure causing engine damage. The pipe and screen are serviced as an assembly.

5. If pickup screen and suction pipe assembly require replacement, mount pump in a soft-jawed vise and extract the suction pipe from the pump.

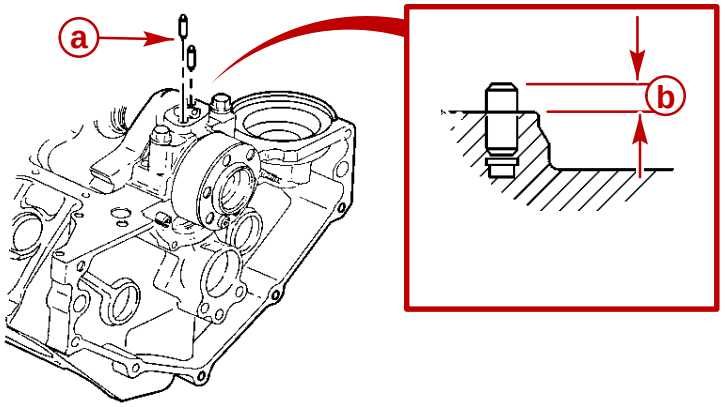
Cleaning

1. Clean all parts in cleaning solvent.
2. Dry parts with compressed air.

Inspection

IMPORTANT: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replacement of entire oil pump assembly is necessary.

1. Inspect pump body and cover for cracks or excessive wear.
2. Inspect pump gears for damage and excessive wear, such as chipped teeth and galling.
3. Check gear shafts in pump body for galling, scoring, or excessive shaft-to-bore clearance.
4. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
5. Inspect pickup screen and suction pipe assembly for damage.
6. Check pressure regulator valve for smooth, non-binding fit in bore of oil pump cover.
7. Inspect the oil pump locator dowel pins for damage and proper height.



77874

a - Dowel pins
b - Oil pump dowel pin height

Description	5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Oil pump dowel pin height	6.4 mm (0.25 in.)

Reassembly

IMPORTANT: Liberally coat oil pump internal parts before installation.

1. Liberally coat surfaces of pressure regulator valve, pressure relief spring, and pressure regulator bore in oil pump with lubricant.

Description	Where Used	Part Number
Engine Oil	Pressure regulator valve, pressure relief spring and pressure regulator bore	Obtain locally

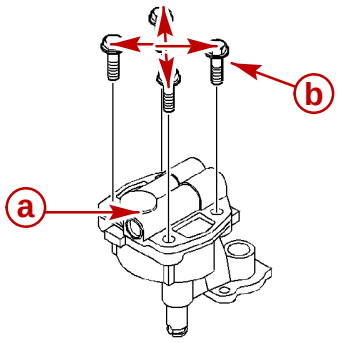
⚠ CAUTION

Pressure regulator valve spring is compressed. Use care when removing or installing retaining pin to avoid personal injury.

2. Install pressure regulator valve, a new pressure relief spring if reusing existing pump and retaining pin.
3. Liberally coat surfaces of oil pump gears and shafts with lubricant.

Description	Where Used	Part Number
Engine Oil	Oil pump gears	Obtain locally

4. Install drive gear in pump body.
5. Install idler gear in pump body with smooth side of gear toward pump cover.
6. Align gear teeth marks made in disassembly.
7. Fill gear cavity with engine oil.
8. Install oil pump cover and cover bolts. Torque bolts in a diagonal pattern.



77862

a - Cover
b - Bolts

Description	Nm	lb-in.	lb-ft
Oil pump cover bolt	12	106	

9. Turn oil pump driveshaft by hand to ensure smooth pump operation.

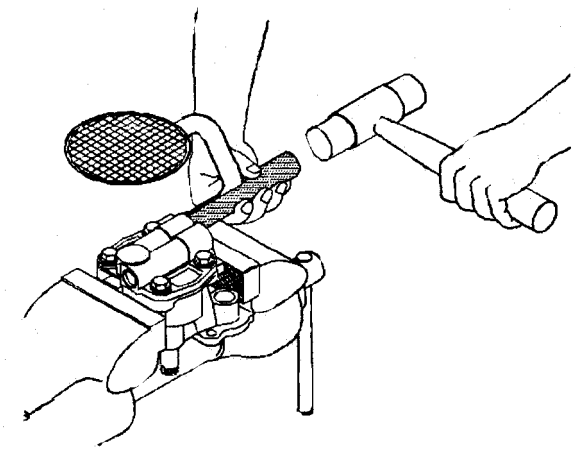
⚠ CAUTION

Be careful of twisting, shearing or collapsing the suction pipe while installing in pump. Pickup screen must be parallel to oil pan bottom when oil pump is installed.

10. If pickup screen and pipe assembly was removed:
    a. Mount pump in a soft-jawed vise.
    b. Apply sealant to end of new pipe.

Description	Where Used	Part Number
Loctite 565 PST	Oil pickup screen pipe to oil pump body	Obtain locally

    c. Using the Suction Pipe Installer Tool, tap the suction pipe in place with a hammer.



78149

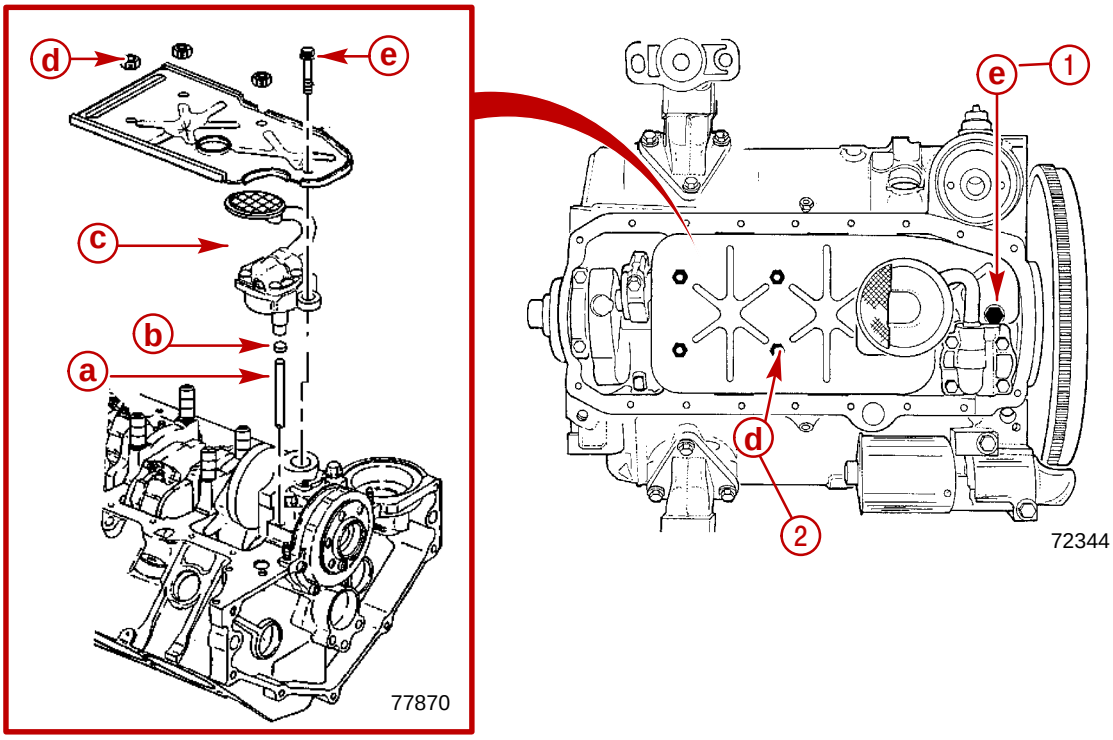
Description	Part Number
Oil Suction Pipe Installer Tool	J21882

    d. Ensure that the pickup screen is parallel to the oil pan bottom when installed.

Installation

IMPORTANT: Do not reuse the oil pump driveshaft retainer. Oil pump driveshaft retainer must be replaced.

1. Align oil pump driveshaft with distributor driveshaft.
2. Install oil pump driveshaft, a new driveshaft retainer, and oil pump to rear main bearing cap.
3. Install crankshaft oil deflector, nuts, and oil pump bolt.
4. Torque oil pump bolt and oil deflector nuts.



a - Driveshaft
b - Driveshaft retainer
c - Oil pump assembly
d - Oil deflector nut
e - Oil pump bolt

Description			Nm	lb-in.	lb-ft
1	Oil pump bolt (to rear crankshaft bearing cap)				
		First pass	20		15
		Final pass	+ 65 degrees		
2	Oil deflector nut		40		30

IMPORTANT: Always install a new oil pan gasket.

5. Install a new oil pan gasket.
6. Install oil pan.

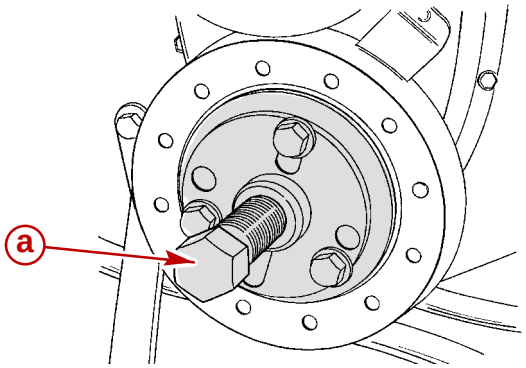
Crankshaft Balancer

Removal

1. Remove serpentine belt .
2. Remove crankshaft drive pulley.
3. Remove crankshaft balancer retaining bolt.

IMPORTANT: Do not use a universal claw type puller to remove crankshaft balancer as outside ring of balancer is bonded in rubber to the hub. Use of claw type puller may break the bond.

4. Remove crankshaft balancer with Remover And Installer Tool.



72345

a - Crankshaft Balancer Remover And Installer Tool

Description	Part Number
Crankshaft Balancer Remover And Installer	J23523-F

Cleaning

1. Clean the crankshaft balancer in cleaning solvent.
2. Dry the parts with compressed air.

Inspection

1. Inspect crankshaft balancer for worn or damaged bolt hole threads.
2. Inspect crankshaft balancer for damaged or deteriorated rubber between inner and outer pieces.
3. Inspect crankshaft balancer for improperly installed or loose balance weights.
4. Inspect crankshaft balancer keyway for damage.

Installation

IMPORTANT: The inertia weight section of the crankshaft balancer is bonded to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the crankshaft balancer.

1. Coat seal surface of crankshaft balancer with engine oil.

Description	Where Used	Part Number
Engine Oil	Crankshaft balancer seal surface	Obtain locally

2. Replace crankshaft key if it is damaged.
3. To prevent oil leaks, apply sealant to crankshaft balancer keyway.

Description	Where Used	Part Number
Loctite 5900 Ultra-Black RTV Silicone Sealant	Crankshaft balancer keyway	92-809826

4. Align the keyway of the crankshaft balancer with the crankshaft balancer woodruff key.
5. Use the Balancer Remover and Installer Tool to press the crankshaft balancer onto the crankshaft.

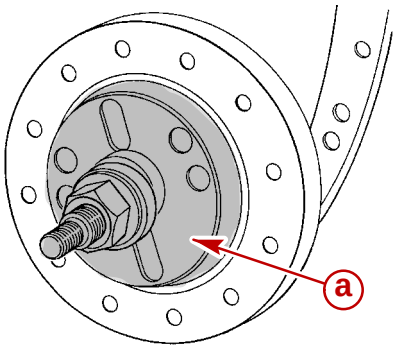
Description	Part Number
Crankshaft Balancer Remover And Installer	J23523-F

   a. Install the plate and bolts onto the front of the crankshaft balancer and torque the bolts.

Description	Nm	lb-in.	lb-ft
J23523-F Plate Bolts	25		18

   b. Install the screw into the end of the crankshaft.
   c. Install the bearing, the washer and the nut onto the screw.
   d. Rotate the nut clockwise until the crankshaft balancer hub is completely seated against the crankshaft position sensor reluctor ring.

6. Remove the Balancer Remover And Installer Tool.

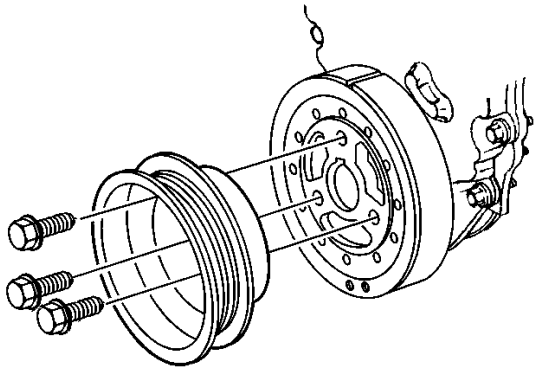


72346

a - Crankshaft Balancer Remover And Installer Tool

Description	Part Number
Crankshaft Balancer Remover And Installer	J23523-F

7. Install crankshaft pulley. Torque bolts.



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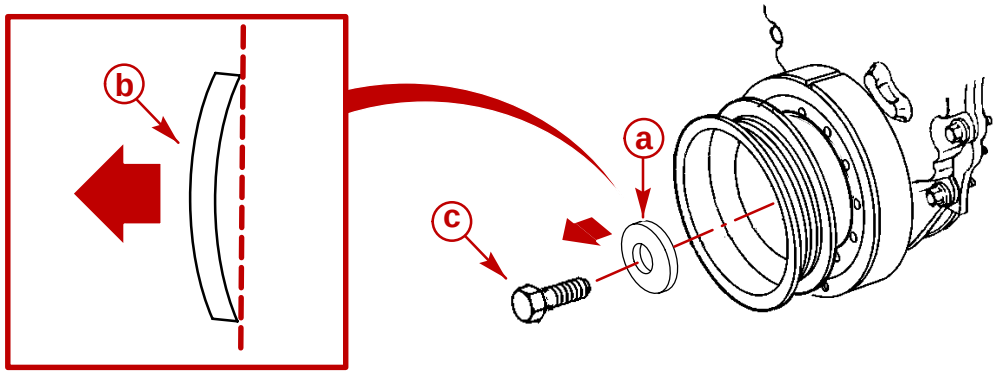
Description	Nm	lb-in.	lb-ft
Crankshaft pulley bolt	58		43

a. Install crankshaft balancer washer with washer crown facing front of engine.

b. Install crankshaft balancer bolt. Torque bolt.



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a - Washer
b - Washer crown
c - Bolt

Description	Nm	lb-in.	lb-ft
Crankshaft balancer (torsional damper) bolt	95		70

8. Install and adjust serpentine belt .

Front Cover Oil Seal (Without Removing Front Cover)

Removal

1. Remove belt and pulleys.
2. Remove crankshaft balancer.
3. Pry seal out of cover from the front with a large screwdriver. Be careful not to distort front cover or damage crankshaft.

Installation

1. Apply sealant to the seal mating surface.

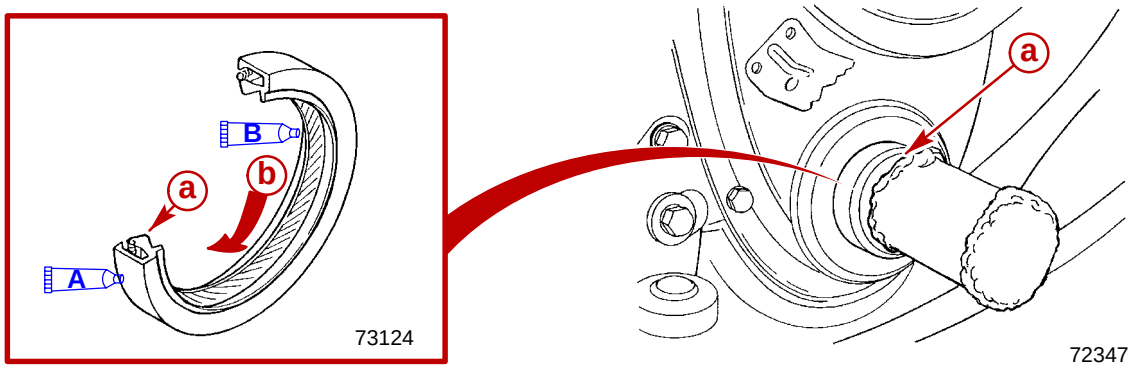
Description	Where Used	Part Number
Loctite 5900 Ultra-Black RTV Silicone Sealant	Front cover seal retainer to seal mating surface	92-809826

2. Lubricate seal edge.

Description	Where Used	Part Number
Engine Oil	Front seal lips	Obtain locally

3. Install new seal with open end of seal inward, using Crankcase Front Cover Aligner / Seal Installer. Drive seal in until it just contacts.

IMPORTANT: Do not use excessive force installing tool.



a - Seal edge
b - Rotation of crankshaft as viewed from front end looking toward flywheel end
c - Crankcase Front Cover Aligner / Seal Installer

Description	Part Number
Cover Aligner / Seal Installer	J35468

Description		Where Used	Part Number
A	Loctite 5900 Ultra-Black RTV Silicone Sealant	Front cover seal retainer-to-seal mating surface	92-809826
B	Engine Oil	Front seal lips	Obtain locally

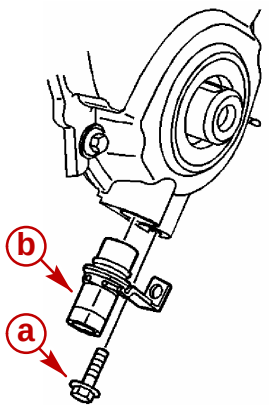
4. Reinstall crankshaft balancer.

Front Cover

Removal

1. Drain seawater and closed cooling systems.
2. Remove the serpentine belt.
3. Remove the crankshaft pulley.
4. Remove the hoses from the water circulating pump.
5. Remove crankshaft balancer.
6. Remove water circulating pump.
7. Remove oil pan.

8. Remove the crankshaft position sensor.



77871

a - Sensor bolt
b - Sensor

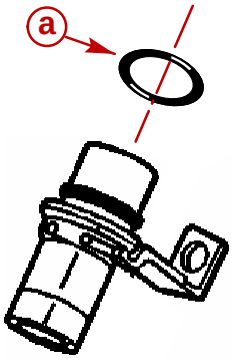
IMPORTANT: Crankcase front cover is not reusable per manufacturer's specification. It must be replaced if removed.

9. Remove and discard crankcase front cover.

Cleaning and Inspection

IMPORTANT: Surfaces must be clean or oil may leak.

1. Clean old gasket material and sealant from sealing surfaces on engine block.
2. Remove and discard the crankshaft position sensor O-ring seal.



78151

a - Sensor O-ring

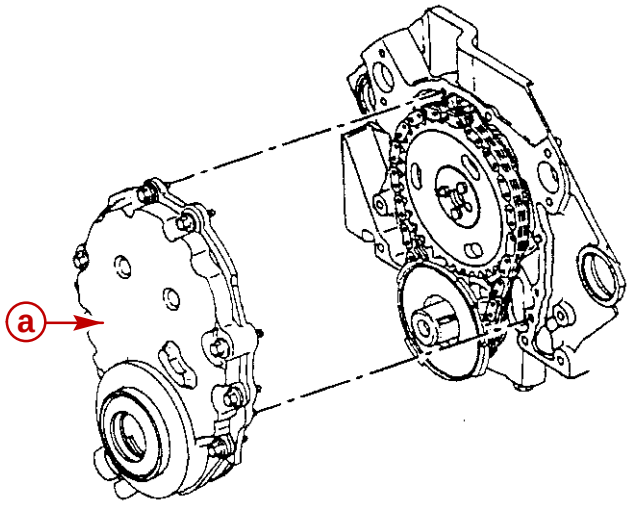
Installation

NOTE:*New front covers are complete with gasket material and a seal.*

1. Lubricate seal edge.

Description	Where Used	Part Number
Engine Oil	Front cover seal edge	Obtain locally

2. Install new front cover, ensuring holes in cover align with dowel pins in block. Torque front cover bolts.



77865

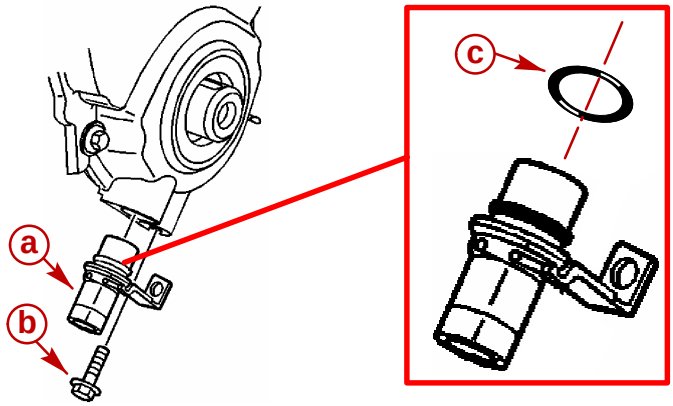
a - Front cover

Description	Nm	lb-in.	lb-ft
Front cover bolt	12	106	

3. Install a new crankshaft position sensor O-ring seal.

IMPORTANT: Ensure that the crankshaft position sensor is fully seated in the front cover. Erratic engine operation can occur if sensor is not completely and properly mounted.

4. Install crankshaft position sensor. Ensure that the sensor is fully seated in cover.
5. Install crankshaft position sensor bolt. Torque bolt.



77871

a - Sensor
b - Sensor bolt
c - O-ring

Description	Nm	lb-in.	lb-ft
Crankshaft position sensor bolt	9	80	

6. Install the oil pan.
7. Install the crankshaft balancer.
8. Install the water circulating pump.
9. Install the hoses to the water circulating pump.
10. Fill the crankcase with engine oil.
11. Refill the closed cooling system, if equipped.
12. Install the crankshaft pulley.
13. Install the serpentine belt.

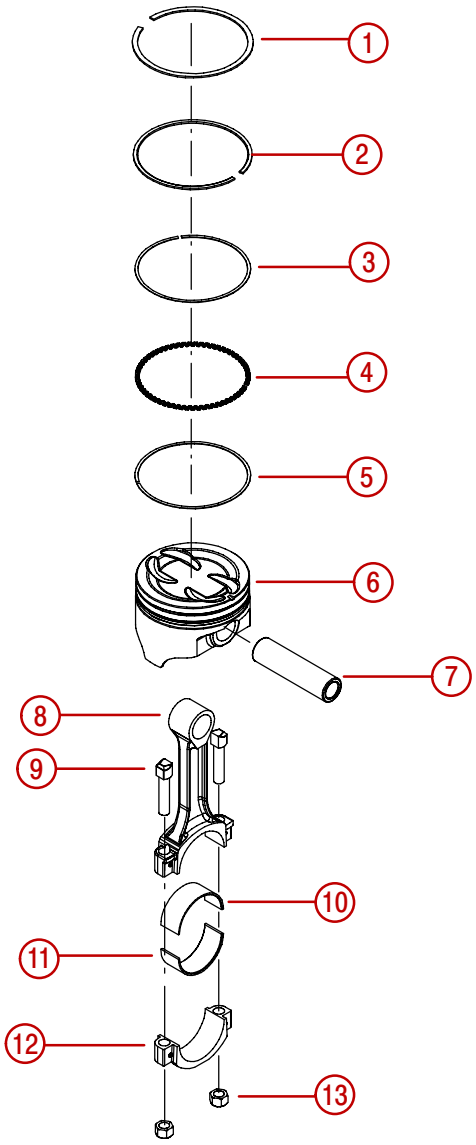
⚠CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

14. Provide sufficient water supply to water inlet holes.
15. Start engine and check for water and oil leaks.

Connecting Rod, Bearings, And Piston Assembly

Exploded View



77888

1 - Upper compression ring
2 - Lower compression ring
3 - Upper oil control ring
4 - Oil control ring spacer
5 - Lower oil control ring
6 - Piston
7 - Piston pin
8 - Connecting rod
9 - Bolt
10 - Upper bearing half
11 - Lower bearing half
12 - Bearing cap
13 - Nut

Removal

1. Remove the engine cover.
2. Drain seawater and closed cooling systems.
3. Drain engine oil from pan.
4. Remove all components on the front of the engine.
5. Remove exhaust elbow and manifold assemblies.
6. Remove the valve covers.
7. Remove distributor and intake manifold assembly.
8. Remove cylinder heads.
9. Remove dipstick tube and oil pan.
10. Remove crankshaft oil deflector and oil pump.
11. Using a ridge reamer, remove any ridge or combustion deposits from top of cylinder bore.
    a. Turn crankshaft until piston is at bottom of stroke.
    b. Place a cloth on top of piston to collect cuttings.
    c. Use the Cylinder Bore Ridge Reamer to remove ridge or deposits.

Description	Part Number
Cylinder Bore Ridge Reamer	J24270

    d. Turn crankshaft until piston is at top of stroke.
    e. Remove cloth and cuttings.

12. Turn crankshaft to gain access to connecting rods and bolts.

IMPORTANT: Mark the location of each connecting rod assembly so that they can be reassembled in the same location later.

13. Mark connecting rods and bearing caps to corresponding cylinder number (port bank 1, 3, 5 and 7; starboard bank 2, 4, 6 and 8 from front to rear on same side as piston thrust).

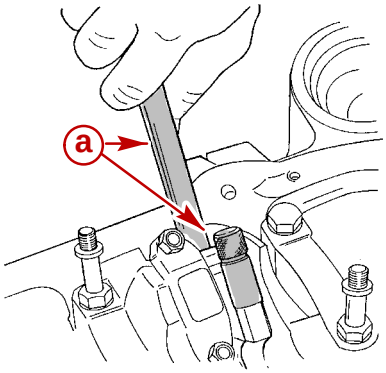
IMPORTANT: Before removing the connecting rod cap, mark and organize the connecting rods and caps so that they can be installed in the same location later.

IMPORTANT: Mark or identify each connecting rod assembly to ensure placement in original location during reassembly.

14. Remove connecting rod bearing cap.

IMPORTANT: Connecting rod bolt threads can damage crankshaft journal and cylinder bore.

15. Cover connecting rod bolt threads with protective caps.



72364

a - Protective cap

16. With bearing caps removed, it is acceptable to use clean rubber tubing or Connecting Rod Bolt Guides on connecting rod bolts as protective caps.

Description	Part Number
Connecting Rod Guide Tool (3/8 -24)	J5239

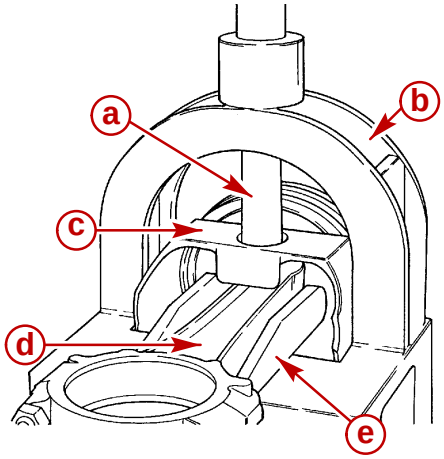
17. Push piston and connecting rod out of cylinder.

IMPORTANT: The mating surfaces of the connecting rods and the connecting rod bearing caps form an individual fit and as a result must not be interchanged or damaged under any circumstances. To avoid damage, do not lay connecting rods or connecting rod bearing caps on their mating surfaces.

18. Remove the connecting rod bearings. Keep the bearings with the original connecting rod and connecting rod cap together as a matched set.

Disassembly

1. Remove the piston rings from the pistons.
2. Press piston pin from connecting rod using a Piston Pin Tool. Follow tool manufacturer's instructions.



72365

a - Piston pin remover
b - Arched base
c - Piston
d - Connecting rod
e - Rod support

Description	Part Number
Piston Pin Tool	J24086-C

3. Mark, separate, and organize parts so that they can be reinstalled in the same location.

Cleaning

CONNECTING RODS

1. Clean connecting rods in cleaning solvent.
2. Dry parts with compressed air.

CONNECTING ROD BEARINGS

1. Clean connecting rod bearings in cleaning solvent.
2. Wipe bearings clean with a soft cloth. Do not scratch the bearing contact surfaces.
3. Dry parts with compressed air.

PISTONS

IMPORTANT: Do not wire brush any part of a piston.

1. Clean pistons in cleaning solvent.
2. Clean varnish from piston skirts and pins with a suitable cleaning solvent.
3. Clean piston ring grooves.
4. Clean piston oil lubrication holes and slots.
5. Dry parts with compressed air.

PISTON PIN

1. Clean parts in cleaning solvent and dry with compressed air.
2. Dry parts with compressed air.

Inspection

IMPORTANT: Measurements should be taken when components are at room temperature.

CONNECTING ROD

1. Check for twisted and or bent connecting rods.
2. Inspect for nicks and cracks.
3. Inspect for damage to the bearing cap and bolt threads.
4. Replace damaged connecting rods.

CONNECTING ROD BEARINGS

NOTE:*Refer to Crankshaft, Main Bearings and Engine Block - Main Bearings, for examples of bearing failures similar to the following.*

1. Inspect the connecting rod bearings for craters, pockets or flattened sections.
2. Inspect the connecting rod bearings for excessive scoring, discoloration, or damage.
3. Inspect the connecting rod bearings for dirt or debris imbedded in the bearing material.
4. Replace damaged or faulty bearings.

CONNECTING ROD BEARING CLEARANCE - MICROMETER METHOD

Connecting rod bearings are of the precision insert type and do not use shims for adjustment. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and 0.001 in. and 0.002 in. undersize for use with new and used standard size crankshafts. They are also available in 0.010 in. and 0.020 in. undersize for use with reconditioned crankshafts.

When removing a connecting rod cap, you may find a 0.010 in. undersize bearing. These are used in manufacturing for selective fitting.

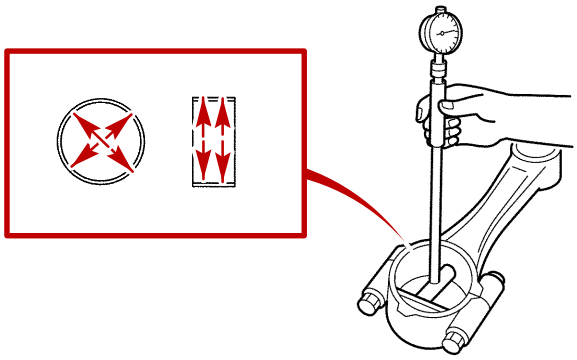
The micrometer method is the preferred method of determining connecting rod bearing clearance.

1. Wipe both upper and lower connecting rod bearings clean.
2. Install the upper and lower connecting rod bearings.
3. Install the bearing cap. Bearing cap MUST be torqued to specification in order to ensure proper reading.
4. In a two pass sequence, torque nuts.

Description		Nm	lb-in.	lb-ft
Connecting rod nut - 5.0 liter (305 CID) and 5.7 liter (350 CID)				
	First pass	27		20
	Final pass (angle torque)	+ 70 degrees		
Connecting rod nut - 6.2 liter (377 CID)				
	First pass	27		20
	Final pass (angle torque)	+ 45 degrees		

5. Use an inside dial indicator to measure the connecting rod bearing inside diameter, out of round and taper. Measure in several places approximately 90 degrees apart and average the measurements.

IMPORTANT: Do not measure diameter close to split line for rod and bearings. Bearings are eccentric and false readings could occur.

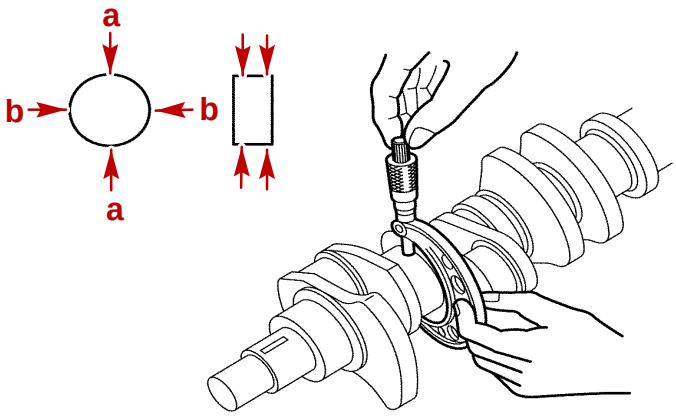


77217

Measuring connecting rod bearing inside diameter

6. Record the measurements.

7. Wipe crankshaft connecting rod journal clean of oil.
8. Using a micrometer measure crankshaft connecting rod journal diameters at points "**a**" and "**b**" on one side of journal then repeat measurements on opposite side of journal.



22215

Connecting rod journal measurement - typical crankshaft shown

Description		**5.0 liter (305 CID) / 5.7 liter (350 CID)**
Diameter		56.505–56.533 mm (2.2246-2.2257 in.)
Taper	Production	0.007 mm (0.0003 in.)
	Service limit	0.025 mm (0.0010 in.)
Out of round	Production	0.007 mm (0.0003 in.)
	Service	0.025 mm (0.0010 in.)

Description		**6.2 liter (377 CID)**
Diameter		53.284–53.334 mm (2.0977-2.0997 in.)
Taper	Production	0.025 mm (0.0010 in.)
	Service limit	
Out of round	Production	0.025 mm (0.0010 in.)
	Service	

9. If journal diameters are not within specifications, replace or recondition the crankshaft.

⚠ CAUTION

Avoid bearing failure. If a bearing is being fitted to an out-of-round journal, be sure to fit bearing to the maximum diameter of the journal. If the bearing is fitted to the minimum diameter and the journal is out of round 0.0254 mm (0.001 in.), interference between the bearing and journal will result in rapid bearing failure.

10. If journal diameters are within specifications, determine bearing clearance by subtracting the crankshaft connecting rod journal outer diameter from the inner diameter of the bearing.

Description		5.0 liter (305 CID) /5.7 liter (350 CID)
Clearance	Production	0.033-0.078 mm (0.0013-0.0031 in.)
	Service limit	0.025-0.063 mm (0.0010-0.0025 in.)

Description		6.2 liter (377 CID)
Clearance	Production	0.033-0.088 mm (0.0013-0.0035 in.)
	Service limit	0.025-0.076 mm (0.0010-0.0029 in.)

11. If the clearance exceeds specifications, select a new, correct size bearing and determine the clearance.

CONNECTING ROD BEARING CLEARANCE – PLASTIC GAUGE METHOD

The plastic gauge method is an optional method of determining connecting rod bearing clearance. The preferred method is the micrometer method.

1. Wipe both upper and lower bearings and crankshaft connecting rod journal clean of oil.
2. Install the bearings in the connecting rod and cap.

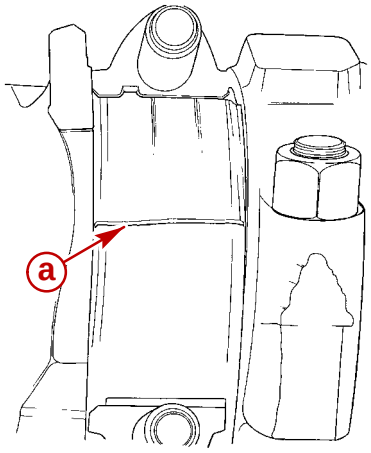
⚠ CAUTION

Avoid possible engine bearing failure. The connecting rod and upper bearing must be seated against the connecting rod journal before installing the lower bearing and rod cap. Unreliable measurement may result if the journal and upper bearing are not fully seated.

3. Rotate the crankshaft or move the connecting rod until the upper bearing is fully seated against the connecting rod journal being measured.

IMPORTANT: Position the gauging plastic on the crankshaft journal in an area that will be the middle of the bearing shell.

4. Place a piece of gauging plastic parallel to the crankshaft on the middle of the open crankshaft connecting rod journal surface as shown.



72361

a - Gauging plastic

5. Install the bearing cap.

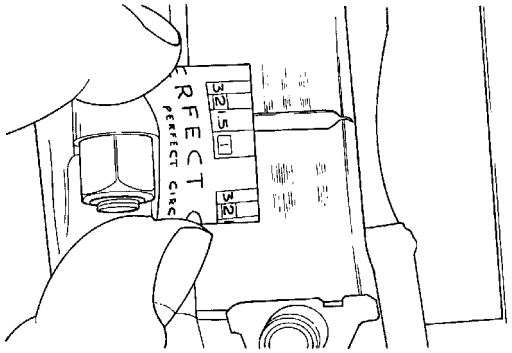
IMPORTANT: Bearing cap MUST be torqued as specified to ensure proper measurement. Variations in torque affect the compression of the plastic gauge.

6. In a two pass sequence, torque nuts.

Description		Nm	lb-in.	lb-ft
Connecting rod nut - 5.0 liter (305 CID) and 5.7 liter (350 CID)				
	First pass	27		20
	Final pass (angle torque)	+ 70 degrees		
Connecting rod nut - 6.2 liter (377 CID)				
	First pass	27		20
	Final pass (angle torque)	+ 45 degrees		

IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.

7. Without rotating crankshaft, remove the bearing cap and use the scale on the gauging plastic envelope to measure the gauging plastic width at the widest point.



72362

Measuring connecting rod bearing clearance

Description		5.0 liter (305 CID) / 5.7 liter (350 CID)
Clearance	Production	0.033-0.078 mm (0.0013-0.0031 in.)
	Service limit	0.025-0.063 mm (0.0010-0.0025 in.)

Description		6.2 liter (377 CID)
Clearance	Production	0.033-0.088 mm (0.0013-0.0035 in.)
	Service	0.025-0.076 mm (0.0010-0.0029 in.)

8. If the clearance exceeds specifications, select a new, correct size bearing and remeasure the clearance. A standard and undersized connecting rod bearing combination may result in the proper clearance.

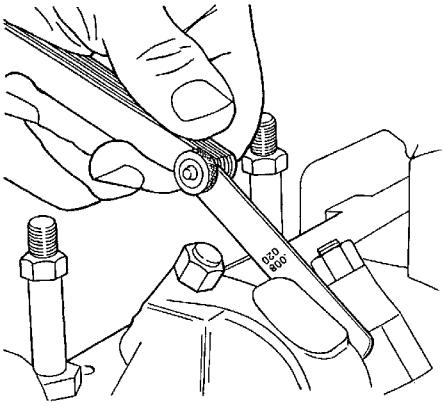
NOTE:*If clearance cannot be brought to within specifications, the crankshaft connecting rod journal will have to be ground undersize. If the connecting rod journal is already at maximum undersize, replace crankshaft.*

9. Coat the selected bearing surface with oil.
10. Install the rod cap.
11. In a two pass sequence, torque nuts.

Description		Nm	lb-in.	lb-ft
Connecting rod nut - 5.0 liter (305 CID) and 5.7 liter (350 CID)				
	First pass	27		20
	Final pass (angle torque)	+ 70 degrees		
Connecting rod nut - 6.2 liter (377 CID)				
	First pass	27		20
	Final pass (angle torque)	+ 45 degrees		

CONNECTING ROD SIDE CLEARANCE

1. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankshaft) to ensure clearance.
2. Measure all connecting rod side clearances between connecting rod caps.



72363

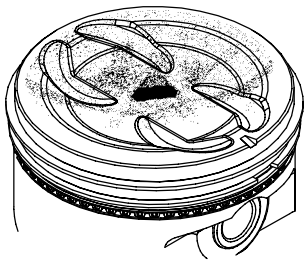
Measuring connecting rod side clearance

Description	5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Rod side clearance	0.15-0.61 mm (0.006-0.024 in.)

PISTONS

NOTE:*Cylinder bore and taper must be within specifications before pistons can be considered for re-use.*

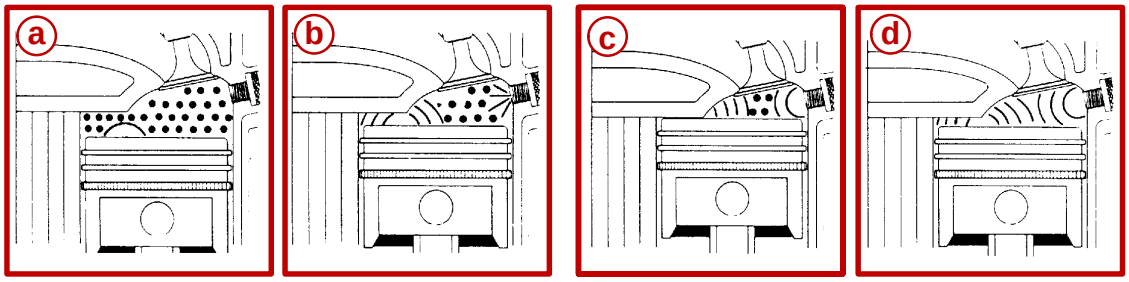
1. Replace pistons that are damaged or show signs of excessive wear.
2. Inspect the piston for damage caused by pre-ignition.



77889

Pre-ignition damage

Pre-ignition is abnormal fuel ignition caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion on the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.



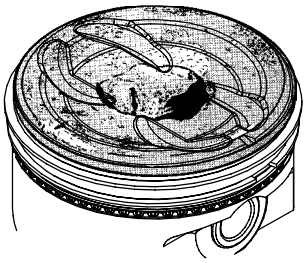
72314

a - Ignited by hot deposits
b - Regular ignition spark
c - Ignites remaining fuel
d - Flame fronts collide

3. Inspect engine for causes of pre-ignition damage to pistons:
   a. Hot spots in the combustion chamber from glowing deposits (due to the use of improper oils and/or fuels).
   b. Overheated spark plug electrodes (improper heat range or defective plug).
   c. Any other foreign material in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material that could serve as a source for pre-ignition problems.

NOTE:*Engine failures that result from the foregoing conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.*

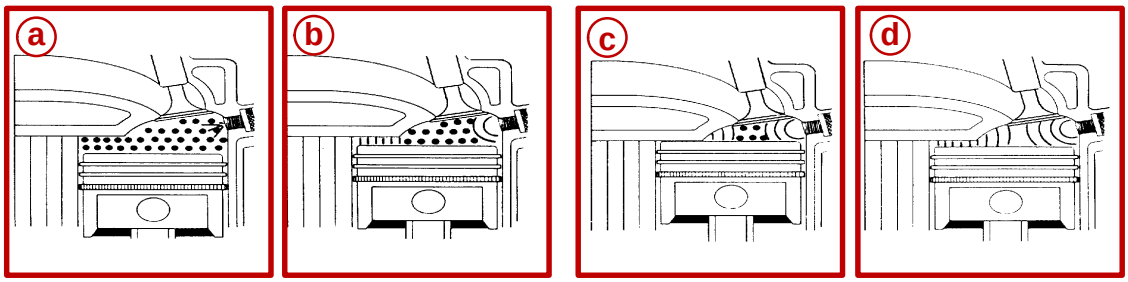
4. Inspect the piston for damage caused by detonation.



77889

Detonation damage

Detonation, commonly called fuel knock, spark knock or carbon knock, is abnormal combustion of the fuel causing the fuel to explode violently. The explosion causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition.



72315

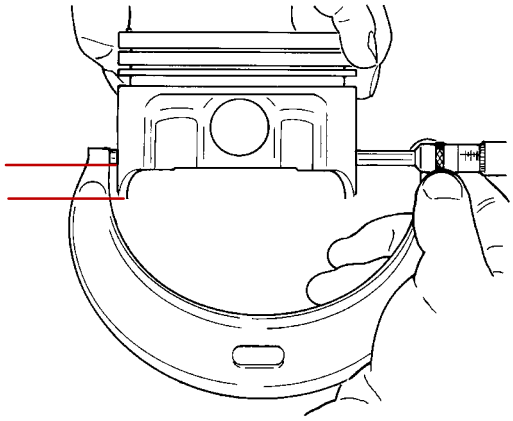
a - Spark occurs
b - Combustion begins
c - Combustion continues
d - Detonation occurs

IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

5. Inspect engine for causes of detonation damage to pistons:
   a. Use of low octane gasoline or neglecting engine maintenance.
   b. Lean fuel mixture at or near full throttle (could be caused by leaking intake manifold).
   c. Cross-firing spark plugs.
   d. Excess accumulation of deposits on piston and/or combustion chamber that result in higher compression ratio.
   e. Inadequate cooling of engine due to deterioration of cooling system.

NOTE:*Engine failures that result from the foregoing conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.*

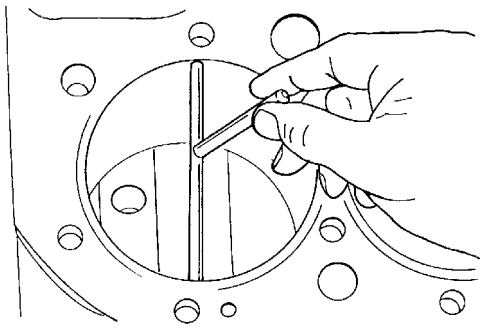
6. Inspect piston for cracked ring lands, skirts and pin bosses, wavy or worn ring lands, scuffed or damaged skirts, and eroded areas at top of piston.
7. Inspect ring grooves for nicks and burrs that might cause rings to bind.
8. Inspect piston wear by checking clearance as follows:
   a. Measure piston diameter 11 mm (0.433 in.) from the bottom of the skirt at a right angle to the piston pin bore as shown.



72624

Measuring piston diameter

   b. Measure cylinder bore diameter with a telescope gauge 64 mm (2-1/2 in.) from top of cylinder bore at 90 degrees from crankshaft centerline as follows.



72386

Measuring cylinder bore

Description	**5.0 liter (305 CID)**	**5.7 liter (350 CID) / 6.2 liter (377 CID)**
Diameter	94.894-94.947 mm (3.7360-3.7381 in.)	101.618-101.643 mm (4.0007-4.0017 in.)

Description		**5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)**
Out of round	Production	0.025 mm (0.001 in.) maximum
	Service	0.05 mm (0.002 in.) maximum
Taper	Production -thrust side	0.012 mm (0.0005 in.) maximum
	Production - relief side	0.025 mm (0.001 in.) maximum
	Service limit	0.025 mm (0.001 in.) over production

c. Subtract piston diameter from cylinder bore diameter to determine piston to bore clearance.

d. Replace the piston if the piston bore clearance is less than specified. Refer to Crankshaft, Main Bearings, And Engine Block for cylinder reconditioning and piston replacement.

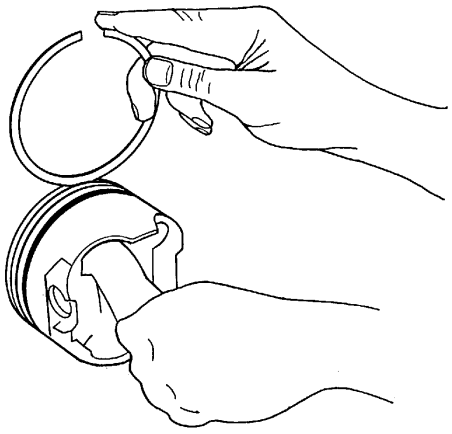
Description	5.0 liter (305 CID)	5.7 liter (350 CID)
Production	0.018-0.061 mm (0.0007-0.0024 in.)	0.018-0.053 mm (0.0007-0.0020 in.)
Service	0.018-0.068 mm (0.0007-0.0026 in.)	0.018-0.061 mm (0.0007-0.0024 in.)

Description	6.2 liter (377 CID)
Production	0.018-0.053 mm (0.0007-0.0021 in.)
Service	0.018-0.068 mm (0.0007-0.0027 in.)

9. Insert edge of rings into respective piston ring groove and roll ring entirely around the groove to ensure that ring moves freely.

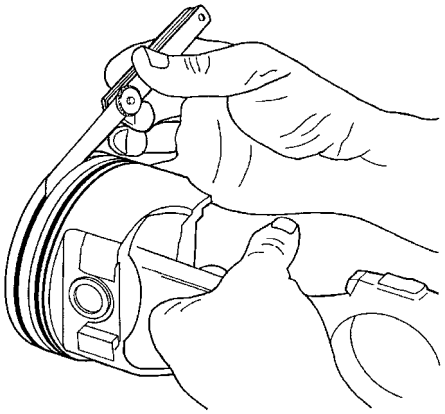
IMPORTANT: Do not remove excess material in the following step. Verify with feeler gauge and compare to specifications.

a. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, recheck with another ring.



72366

10. Using a feeler gauge, measure the clearance between the piston ring and the piston ring groove at several points around the piston.



72367

Measuring ring groove clearance

Top compression

Description		**5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377CID)**
Groove clearance	Production	0.030-0.070 mm (0.0012-0.0027 in.)
	Service	0.030-0.090 mm (0.0012-0.0035 in.)

Second compression

Description		**5.0 liter (305 CID)**	**5.7 liter (350 CID)**
Groove clearance	Production	0.030-0.074 mm (0.0012-0.0029 in.)	0.038-0.080 mm (0.0015-0.0031 in.)
	Service	0.030-0.090 mm (0.0012-0.0035 in.)	0.040-0.100 mm (0.0016-0.0039 in.)

Description		**6.2 liter (377 CID)**
Groove clearance	Production	0.040-0.080 mm (0.0015-0.0030 in.)
	Service	0.040-0.100 mm (0.0015-0.0040 in.)

Oil control

Description		**5.0 liter (305 CID)**	**5.7 liter (350 CID)**
Groove clearance	Production	0.051-0.203 mm (0.0020-0.0080 in.)	0.046-0.096 mm (0.0018-0.0038 in.)
	Service	0.051-0.22 mm (0.0020-0.0009 in.)	0.046-0.100 mm (0.0018-0.0039 in.)

Description		**377CID(6.2 l)**
Groove clearance	Production	0.051-0.17 mm (0.0020-0.006 in.)
	Service	0.051-0.195 mm (0.0020-0.0076 in.)

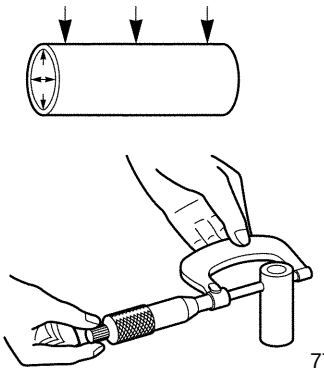
11. Replace piston if groove clearance exceeds the specified limit.

PISTON PINS

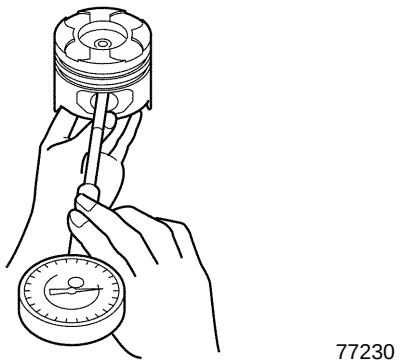
IMPORTANT: Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.

NOTE:*Piston pin bores and piston pins must be free of varnish and scuffing when measured.*

1. Inspect piston pin bores and piston pins for wear.
   a. Measure piston pin with a micrometer.
   b. Measure piston pin bore with a dial bore gauge or inside micrometer.



Measuring piston pin



Measuring piston pin bore

   c. Subtract piston pin diameter from piston pin bore diameter to determine clearance.

Description		**5.0 liter (305 CID)**	**5.7 liter (350 CID)**
Diameter		23.545-23.548 mm (0.9270-0.9271 in.)	
Clearance	Production	0.010-0.020 mm (0.0004-0.0008 in.)	0.013-0.023 mm (0.0005-0.0009 in.)
	Service limit	0.013-0.025 mm (0.0005-0.0010 in.) maximum	
Fit in rod		0.012-0.050 mm (0.0005-0.0020 in.) interference	

Description		**6.2 liter (377 CID)**
Diameter		23.545-23.548 mm (0.9269-0.9270 in.)
Clearance	Production	0.013-0.023 mm (0.0005-0.0009 in.)
	Service limit	0.013-0.025 mm (0.0005-0.00098 in.) maximum
Fit in rod		0.021-0.040 mm (0.00082-0.00157 in.) interference

   d. If clearance exceeds service limit, replace piston and piston pin assembly.

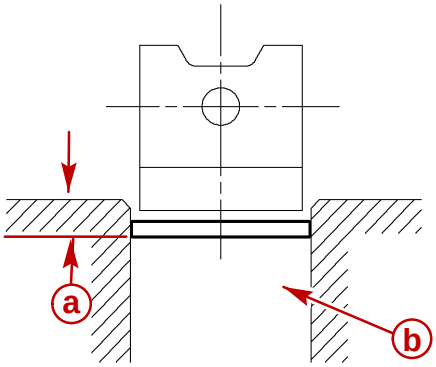
PISTON RING GAP

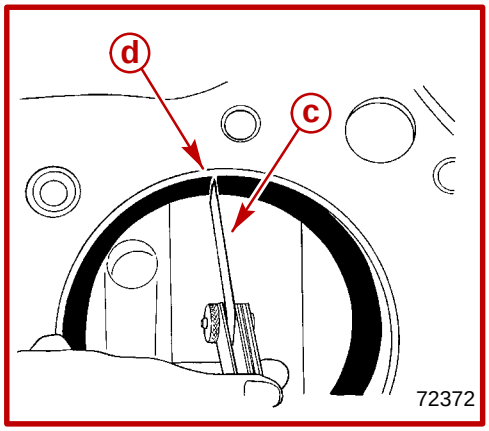
IMPORTANT: Fit each compression ring to the cylinder in which it is going to be used.

1. Insert the piston ring into the cylinder bore.
2. Using a piston inserted upside down, push the piston ring into the cylinder bore until it reaches measuring point "**a**."

NOTE:Ensure that piston ring is not slanted to one side or the other. It must be perfectly square with cylinder wall.

3. Using a feeler gauge, measure the piston ring gap.





77190

Piston ring gap

a - Measurement point - 6 mm (1/4 in.)
b - Cylinder bore
c - Feeler gauge
d - Ring gap

Top compression

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Gap	Production	0.25-0.51 mm (0.0098-0.020 in.)	0.25-0.40 mm (0.0098-0.016 in.)
	Service	0.25-0.65 mm (0.0098-0.026 in.)	0.25-0.50 mm (0.0098-0.0197 in.)

Description		6.2 liter (377 CID)
Gap	Production	0.25-0.51 mm (0.009-0.020 in.)
	Service	0.30-0.68 mm (0.012-0.027 in.)

Second compression

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Gap	Production	0.46-0.66 mm (0.018-0.026 in.)	0.038-0.058 mm (0.0015-0.023 in.)
	Service	0.46-0.90 mm (0.018-0.035 in.)	0.46-0.80 mm (0.018-0.031 in.)

Description		6.2 liter (377 CID)
Gap	Production	0.46-0.66 mm (0.010-0.020 in.)
	Service	0.51-0.94 mm (0.020-0.037 in.)

Oil control

Description		5.0 liter (305 CID)	5.7 liter (350 CID)
Gap	Production	0.25-0.76 mm (0.0098-0.030 in.)	
	Service	0.25-0.89 mm (0.0098-0.035 in.)	0.25-0.90 mm (0.0098-0.035 in.)

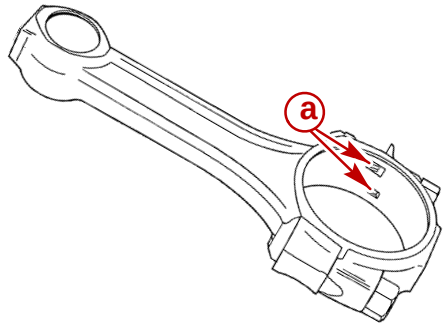
Description		6.2 liter (377 CID)
Gap	Production	0.25-0.76 mm (0.009-0.029 in.)
	Service Limit	0.28-0.81 mm (0.011-0.0320 in.)

4. Replace ring if gap exceeds service limits. If gap between ends of ring is below specifications, remove ring and try another.

Reassembly

IMPORTANT: When reassembling pistons and connecting rods, the following must be kept in mind.

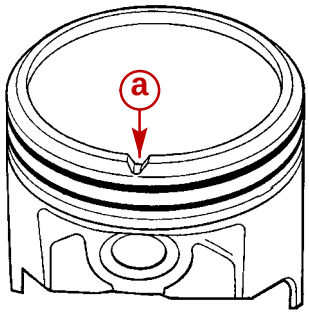
- **Piston and pin are machine fitted to each other and must remain together as a matched set. Do not mix pistons and pins.**
- **If original pistons and / or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they were removed.**
- **Connecting rod bearing tangs are always toward outside of engine block.**



72368

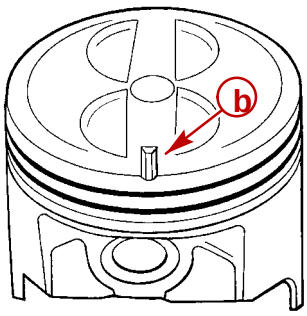
a - Connecting rod bearing tangs

- **Notch on the piston must be positioned toward the front of the engine (water pump end).**



72369

5.0 liter (305 CID)



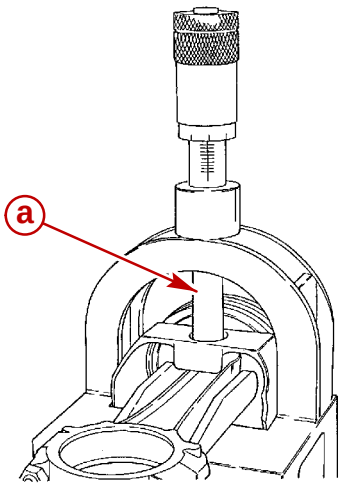
72370

5.7 liter (350 CID) and 6.2 liter (377 CID)

a - Notch
b - Notch

PISTON

1. Assemble piston to connecting rod using Piston Pin Tool. Follow tool manufacturer's instructions.



72371

a - Piston Pin Tool

Description	Part Number
Piston Pin Tool	J24086-C

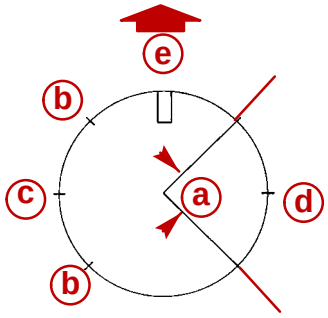
2. Once assembled, check piston for freedom of movement (back and forth, up and down) on connecting rod. Piston should move freely in all directions. If it does not, piston pin bore is tight and piston / pin assembly must be replaced.
3. If a new connecting rod has been installed, mark connecting rod and cap (on side of rod and cap with slots for connecting rod bearing tangs) with cylinder number in which it will be installed.

PISTON RINGS

All compression rings are marked on upper side of ring. When installing compression rings, ensure that marked side is toward top of piston.

Oil control rings are a three-piece type, consisting of two rings and a spacer.

1. Select rings comparable in size to cylinder bore and piston size.
2. Install piston rings as follows:
   a. Install oil control ring spacer in groove.
   b. Hold spacer ends together and install lower oil control piston ring with gap properly located.
   c. Install upper oil control piston ring with gap properly located.
   d. Flex the oil ring assembly to ensure that the ring is free. If binding occurs at any point, determine the cause. If binding is caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, use a new ring.

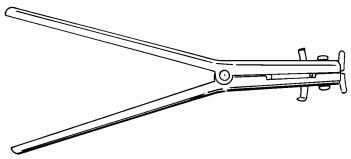


72373

Ring gap location

a - Oil ring spacer gap
b - Oil ring rail gaps
c - Lower compression ring gap
d - Upper compression ring gap
e - Engine front

IMPORTANT: Use Piston Ring Expander for compression ring installation.

Piston Ring Expander		
 73700	Installs and removes the piston rings.	91-24697

e. Using Piston Ring Expander, install lower and upper compression rings with marked side up.

Installation

IMPORTANT: Cylinder bores must be clean before piston installation.

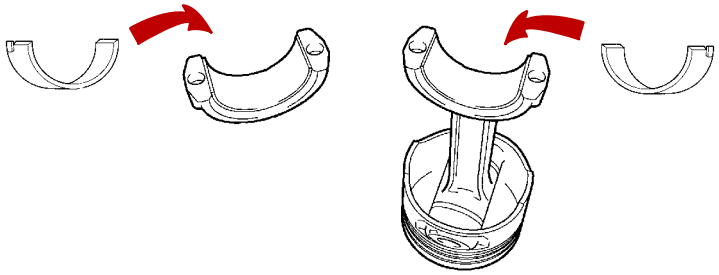
1. Clean cylinder bores with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, lightly lubricate bores several times with light engine oil and clean cloth, then wipe with a clean dry cloth.

Description	Where Used	Part Number
Engine Oil	Cylinder walls	Obtain locally

2. Rotate the crankshaft until the crankpin is at before dead center (BDC) for the cylinder that is ready for first piston to be installed.
3. Carefully wipe any foreign material from the connecting rod bearings and the connecting rod bearing fitting surfaces.

NOTE:*Do not apply engine oil to the bearing back faces and the connecting rod bearing fitting surfaces.*

4. Insert bearing shells into the connecting rod and matching rod cap.

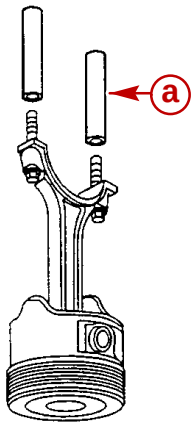


77251

5. Lubricate connecting rod bearings, pistons, rings, and cylinder walls.

Description	Where Used	Part Number
Engine Oil	Connecting rod bearings, pistons, rings and cylinder walls	Obtain locally

6. With bearing caps removed, install Connecting Rod Bolt Guides onto the connecting rod bolts. It is acceptable to use clean rubber tubing for the connecting rod bolt guides.



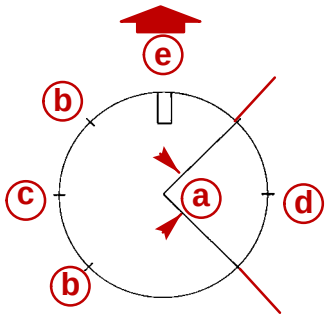
76719

a - Connecting rod bolt guide

Description	Part Number
Connecting Rod Guide Tool (3/8 -24)	J5239

IMPORTANT: Ensure ring gaps are properly positioned.

7. Position ring gaps as shown.

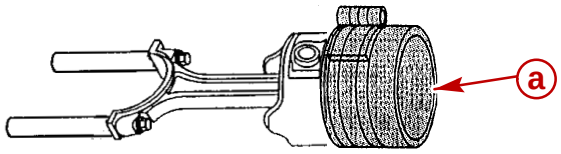


72373

Ring gap location

- **a** - Oil ring spacer gap
- **b** - Oil ring rail gaps
- **c** - Lower compression ring gap
- **d** - Upper compression ring gap
- **e** - Engine front

8. Use Piston Ring Compressor and compress rings.



79397

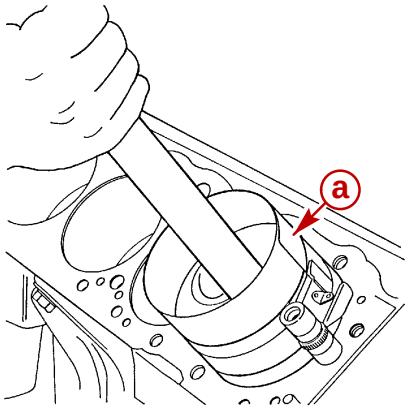
- **a** - Piston Ring Compressor

Description	Part Number
Piston Ring Compressor	J8037

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3, 5 and 7 in left bank and 2, 4, 6 and 8 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with new cylinder number.

9. Install each connecting rod and piston assembly in its respective bore with connecting rod bearing tangs toward the outside of engine block and piston notch toward the front of engine.
10. Guide connecting rod into place on the crankshaft journal with the Connecting Rod Bolt Guide.

11. Hold Piston Ring Compressor firmly against engine block until all piston rings have entered cylinder bore.
12. Using a wooden or plastic hammer handle, lightly tap the piston into bore.



72374

a - Piston Ring Compressor

Description	Part Number
Piston Ring Compressor	J8037

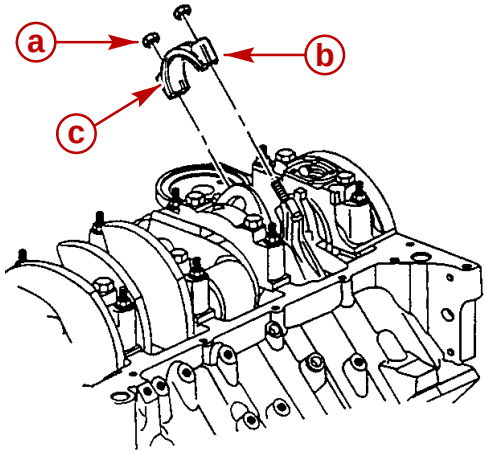
13. Remove Connecting Rod Bolt Guides.
14. Apply a lubricant to the threads and mating faces of each connecting rod cap, bolt, and, nut.

Description	Where Used	Part Number
Engine Oil	Connecting rod and rod cap	Obtain locally

⚠ CAUTION

The connecting rod caps MUST be installed in the correct direction. Reversing the cap direction will result in serious engine damage.

15. Install the connecting rod cap.



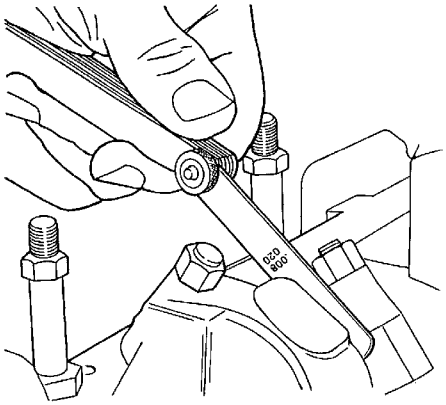
76716

a - Connecting rod nuts
b - Connecting rod caps
c - Lower bearing

16. In a two pass sequence, torque connecting rod cap nuts.

Description		Nm	lb-in.	lb-ft
Connecting rod nut - 5.0 liter (305 CID) and 5.7 liter (350 CID)				
	First pass	27		20
	Final pass (angle torque)	+ 70 degrees		
Connecting rod nut - 6.2 liter (377 CID)				
	First pass	27		20
	Final pass (angle torque)	+ 45 degrees		

17. Lightly tap each connecting rod assembly parallel to the crankpin to ensure clearance.
18. Measure all connecting rod side clearances between connecting rod caps.



72363

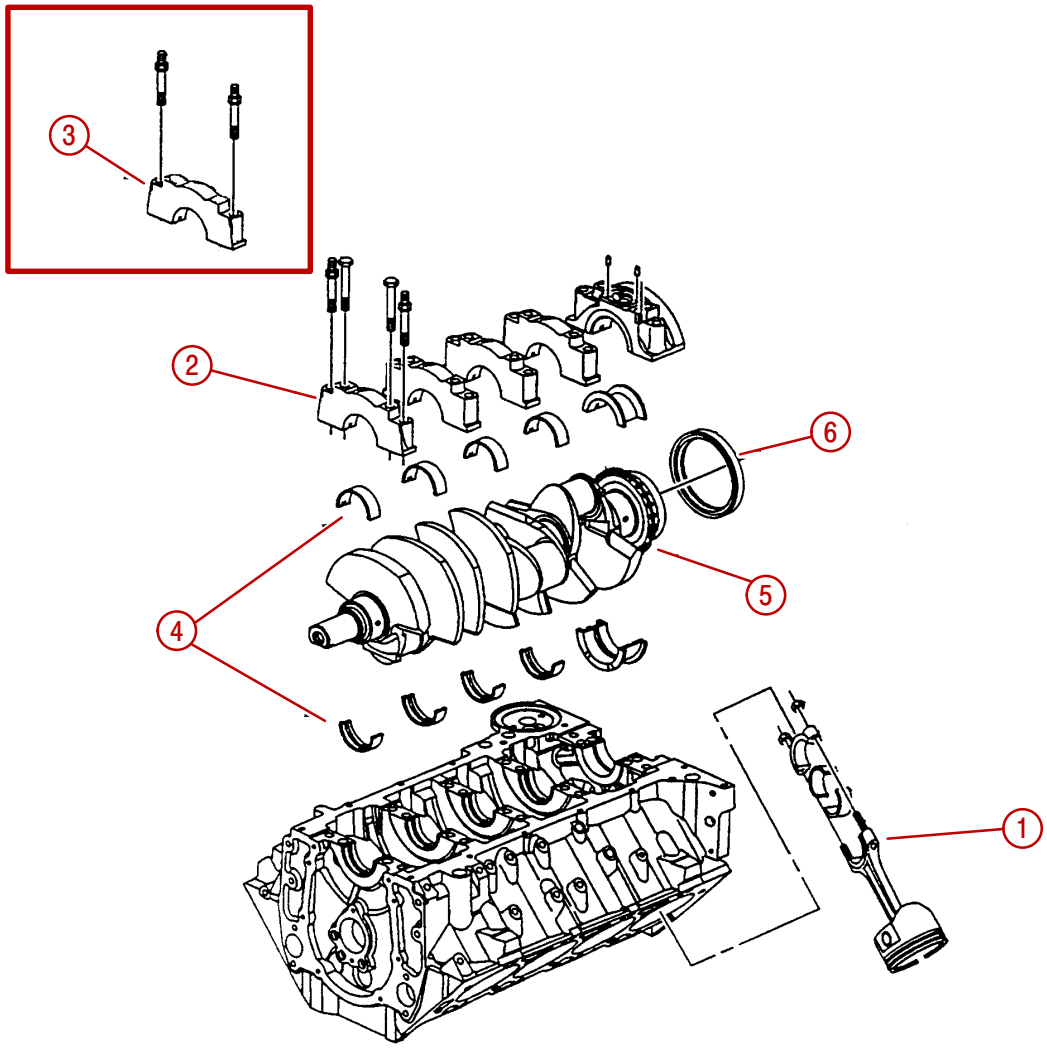
Measuring connecting rod side clearance

Description	5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Rod side clearance	0.15-0.61 mm (0.0059-0.0240 in.)

19. Install oil pump and crankshaft oil deflector.
20. Install dipstick and oil pan.
21. Install cylinder heads.
22. Install intake manifold assembly.
23. Install distributor.
24. Adjust valves.
25. Install valve covers.
26. Install exhaust elbow and manifold assemblies.
27. Fill crankcase with proper viscosity and quantity of oil. Refer to **SECTION 1B**.
28. Install all components removed from the front of the engine.

Crankshaft, Main Bearings, And Engine Block

Exploded View



76682

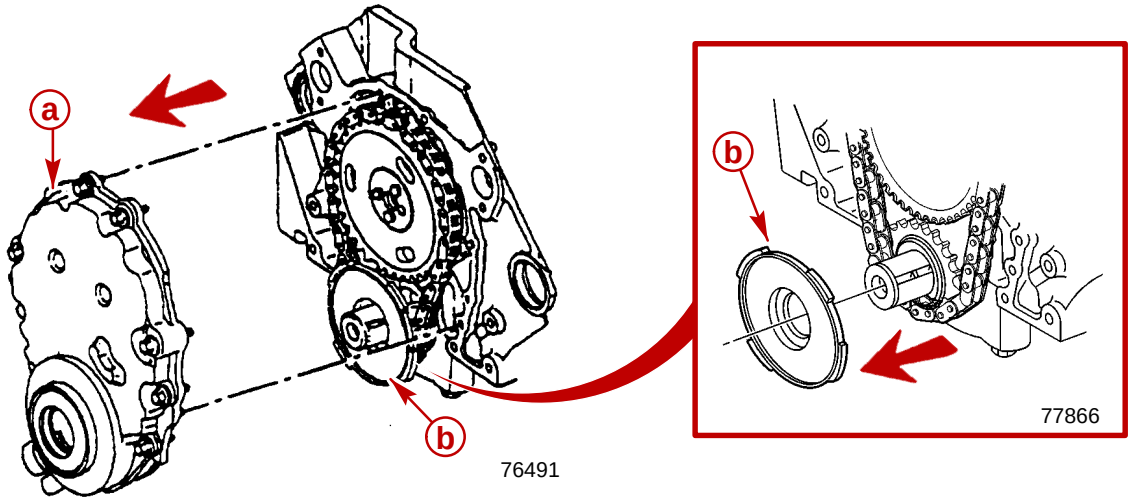
1 - Piston and rod assemblies
2 - Four bolt main bearing cap (some models)
3 - Two bolt main bearing cap (most models)
4 - Main bearings
5 - Crankshaft
6 - Rear main seal

Removal

NOTICE
If only the main bearings are being serviced refer to Installation - Bearings Without Crankshaft Removed.

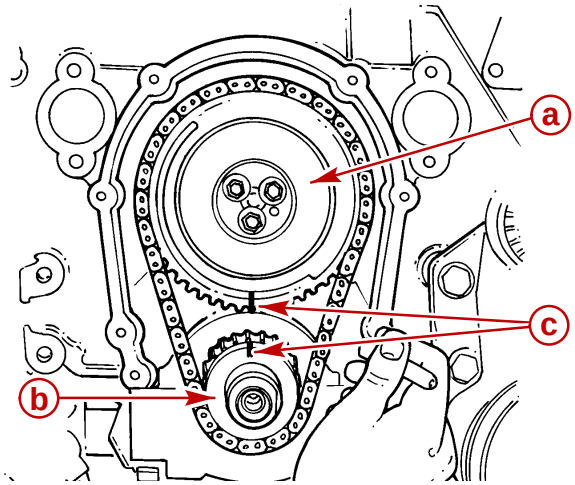
NOTE:*Engine port and starboard cylinder heads are removed for illustration clarity.*

1. **MCM Models**: Remove sterndrive unit.
2. **MIE Models**: Remove transmission.
3. Drain seawater and closed cooling systems.
4. Remove engine from boat.
5. Drain engine oil.
6. Remove starter.
7. Remove flywheel housing.
8. Remove coupler / drive plate.
9. Remove flywheel.
10. Remove serpentine belt .
11. Remove water circulating pump.
12. Remove crankshaft pulley and crankshaft balancer.
13. Remove spark plugs.
14. Remove dipstick tube and oil pan.
15. Remove crankshaft oil deflector and oil pump.
16. Remove crankshaft position sensor. Discard O-ring seal.
17. Remove engine front cover.
18. Remove the crankshaft position sensor reluctor ring.



a - Front cover
b - Reluctor ring

19. Turn crankshaft until timing marks on crankshaft and camshaft sprockets are in alignment or turn engine to cylinder number 1 TDC and mark both gears for alignment in reassembly.



77478

a - Camshaft gear
b - Crankshaft gear
c - Alignment marks

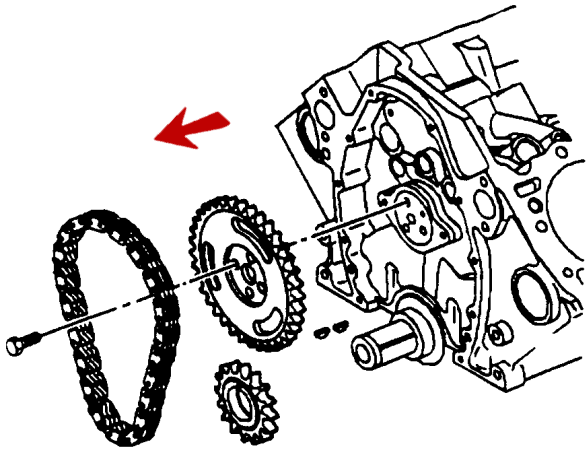
20. Remove camshaft sprocket.

NOTE:*If sprocket does not come off easily, a light tap on the lower edge of the sprocket with a plastic mallet should dislodge it.*

21. Remove timing chain.

22. Remove crankshaft sprocket using Crankshaft Gear Remover.

Description	Part Number
Crankshaft Gear Remover	J5825-A



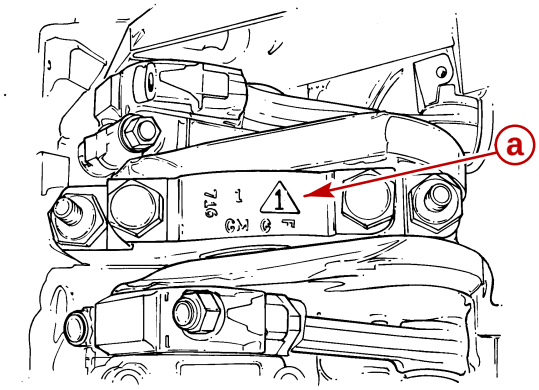
76488

23. Remove rear main seal and retainer.

24. Remove connecting rod and piston assemblies.

IMPORTANT: Inspect bearing caps for orientation marks prior to removal. If no markings exist, make suitable marks before disassembly so that they can be reinstalled in their original locations.

25. Ensure that all bearing caps are marked so that they can be reinstalled in their original locations.

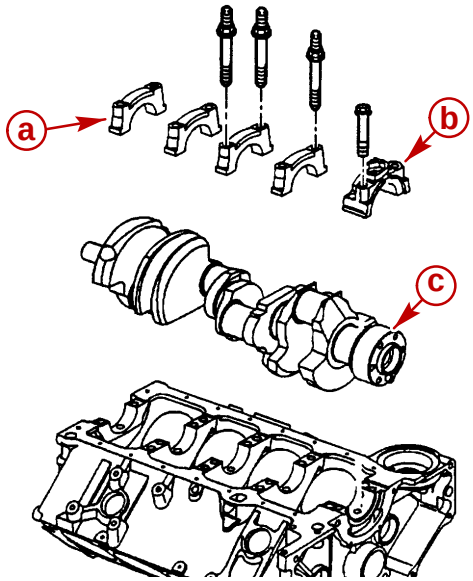


77467

Typical

a - Bearing cap mark

26. Remove main bearing caps and carefully lift crankshaft out of engine block.



76492

Two bolt main bearing caps shown (four bolt similar)

a - Main bearing cap
b - Rear main bearing cap
c - Crankshaft

27. If new main or connecting rod bearings are to be installed, remove main bearing inserts from engine block and bearing caps or connecting rod bearing inserts from connecting rod and caps. Install new bearings.

Cleaning

CRANKSHAFT

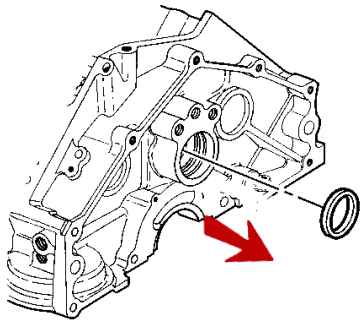
1. Clean the crankshaft in cleaning solvent. Ensure oil passages are clear of all sludge and restrictions.
2. Dry part with compressed air.

MAIN BEARINGS

1. Clean the crankshaft bearings in cleaning solvent. Wipe the crankshaft bearings clean with a soft cloth, do not scratch the crankshaft bearing surfaces.
2. Dry parts with compressed air.

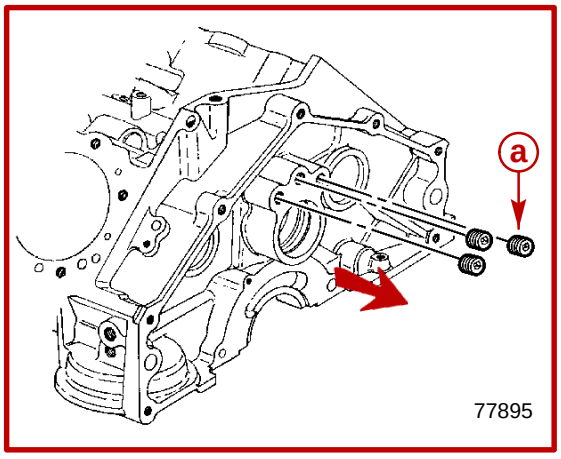
ENGINE BLOCK

1. Remove all engine components.
2. Remove the camshaft rear bearing hole expansion cup plug.

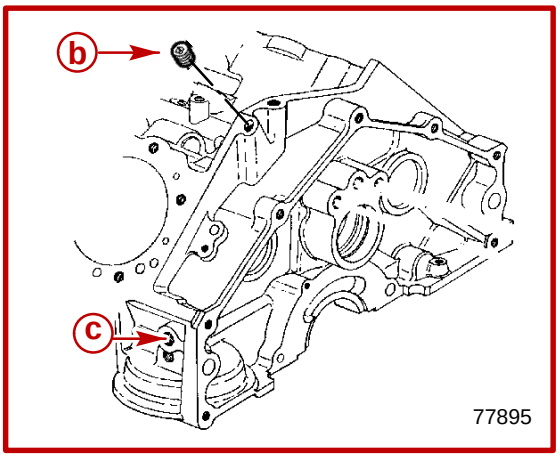


77893

3. Remove oil pressure sender and oil gallery plugs indicated.



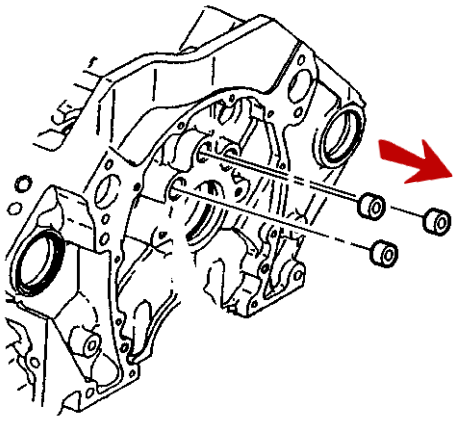
77895



77895

a - Rear oil gallery plugs
b - Left rear top oil gallery plug
c - Oil pressure sender location

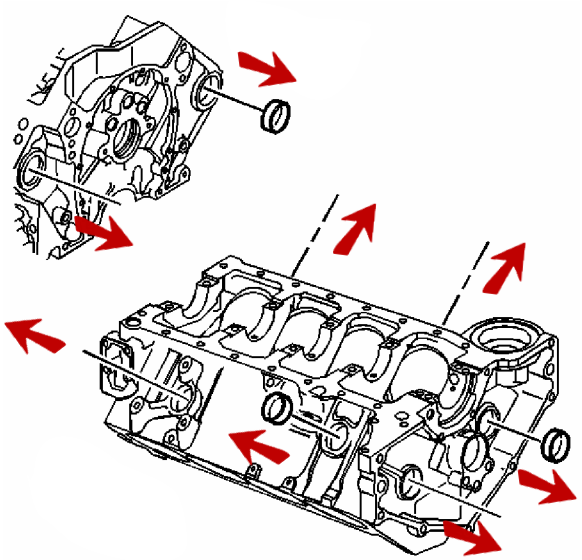
4. Insert a 3/8 in. x 26 in. rod into rear oil gallery holes and drive out (remove) oil gallery plugs at front of engine block. Discard plugs.



77892

NOTE:*The engine block core hole expansion plugs may be removed with a sharp punch or they may be drilled and pried out.*

5. Remove engine block core hole expansion plugs.



77894

6. Clean all sealing surfaces.
7. Remove sealant residue.
8. Clean the engine block with cleaning solvent.
9. Flush the engine block with clean water or steam clean.
10. Clean the cylinder bores.
11. Clean the oil galleries and oil passages.

12. Clean scale and deposits from coolant passages.

⚠ CAUTION

Avoid engine damage. Clean all debris, dirt and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to the engine.

13. Clean the engine block cylinder head bolt holes and dry with compressed air.
14. After cleaning the engine block, spray or wipe the cylinder bores and the machined surfaces with clean engine oil.

Description	Where Used	Part Number
Engine Oil	Cylinder bores and the machined surfaces	Obtain locally

Inspection

CRANKSHAFT

1. Inspect crankshaft for deep grooves, scratches, pitted surfaces, or uneven wear.
2. Inspect crankshaft rear oil seal surface for scoring or damage.
3. Inspect crankshaft oil passages for restrictions.
4. Inspect the thrust journal surface for wear or damage.
5. Inspect the crankshaft threaded bolt holes for damage.
6. Inspect the crankshaft balancer keyway for damage.
7. Measure the main bearing journals with a micrometer for out of round, taper, and undersize.

NOTE:*Measure the crankshaft journal diameter in several places, approximately 90 degrees apart, and average the measurements.*

Description		5.0 liter (305 CID) / 5.7 liter (350 CID)
Diameter	Number 1	62.189-62.212 mm (2.4484-2.4493 in.)
	Number 2, 3, 4	62.181-62.207 mm (2.4481-2.4491 in.)
	Number 5	62.185-62.207 mm (2.4482-2.4491 in.)

Description		6.2 liter (377 CID)
Diameter	Number 1	62.189-62.212 mm (2.4483-2.4492 in.)
	Number 2, 3, 4	62.181-62.207 mm (2.4480-2.4490 in.)
	Number 5	62.177-62.207 mm (2.4479-2.4490 in.)

Description		5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Taper	Production	0.005 mm (0.0002 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum
Out of round	Production	0.005 mm (0.0002 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum

8. Measure connecting rod bearing journals with a micrometer for out of round, taper and undersize.

Description	5.0 liter (305 CID) / 5.7 liter (350 CID)
Diameter	56.505–56.533 mm (2.2246-2.2257 in.)

Description	6.2 liter (377 CID)
Diameter	53.284–53.334 mm (2.0977-2.0997 in.)

Description		5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Taper	Production	0.007 mm (0.0003 in.) maximum
	Service Limit	0.025 mm (0.0010 in.) maximum
Out of round	Production	0.007 mm (0.0003 in.) maximum
	Service	0.025 mm (0.0010 in.) maximum

9. To check crankshaft for runout, support the front and rear main bearings journals in V-blocks.
10. Check at front and rear intermediate journals with a dial indicator.

Description	5.0 liter (305 CID) / 5.7 liter (350 CID)
Runout	0.038 mm (0.0015 in.)

Description	6.2 liter (377 CID)
Runout	0.05-0.20 mm (0.0020-0.0079 in.)

11. Replace or recondition crankshaft if not within specifications.

MAIN BEARINGS

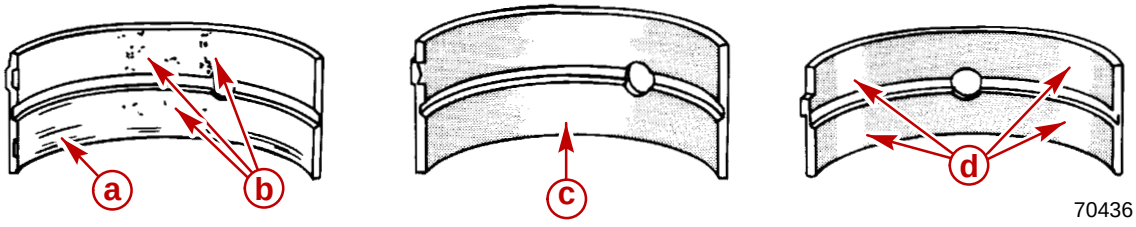
Main bearings are of the precision insert type and do not use shims for adjustment. If clearances are excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and 0.0254 mm(0.001 in.), 0.254 mm (0.010 in.) and 0.508 mm (0.020 in.) undersize.

Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. For this reason you may find 1/2 of a standard insert with 1/2 of a 0.0254 mm (0.001 in.) undersize insert, which will decrease the clearance 0.0127 mm (0.0005 in.) from using a full standard bearing.

When a production crankshaft cannot be precision fitted by this method, it is then ground 0.229 mm (.009 in.) undersize, on only those main journals that cannot be properly fitted. all journals will not necessarily be ground undersize. A 0.229 mm (0.009 in.) undersize bearing and 0.254 mm (0.010 in.) undersize bearing may be used for precision fitting in the same manner as previously described.

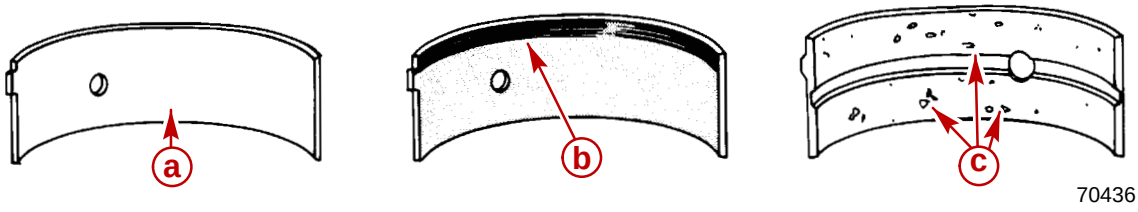
In general, the lower half of the bearing (except number 1 bearing) shows a greater wear and the most distress from fatigue. If upon inspection the lower half is suitable for use, it can be assumed that the upper half is also satisfactory. If the lower half shows evidence of wear or damage, replace both upper and lower halves. Never replace one half without replacing the other half.

Examples of Bearing Failures



Scratched by dirt **Lack of oil** **Improper seating**

a - Scratches
b - Dirt imbedded into bearing material
c - Overlay wiped out
d - Bright (polished) sections

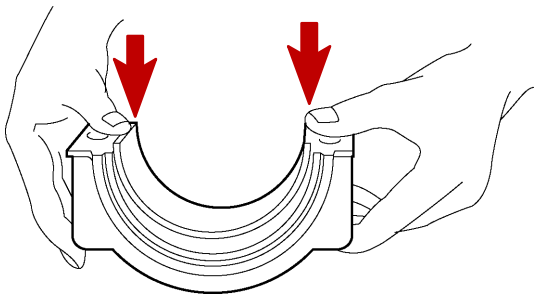


Tapered journal **Radius ride** **Fatigue failure**

a - Overlay gone from entire surface
b - Radius ride
c - Craters or pockets

MAIN BEARING TENSION

1. Ensure that the main bearing is installed under tension. It should require firm pressure to fit the bearing into position.



77214

Main bearing tension

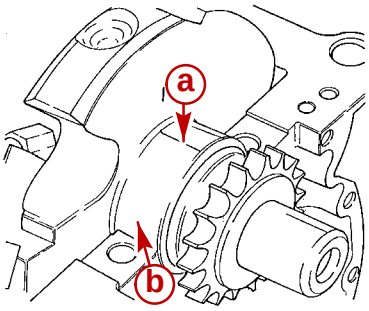
MAIN BEARING CLEARANCE - PLASTIC GAUGE METHOD

To obtain accurate measurements while using Plastigage or its equivalent, engine must be out of the boat and upside down so crankshaft will rest on the upper bearings and total clearance can be measured between lower bearing and journal.

To ensure the proper seating of the crankshaft, all bearing cap bolts should be at specified torque. In addition, the surface of the crankshaft journal and bearing must be wiped clean of oil.

NOTE:*When checking number 1 main bearing, loosen accessory drive belt to prevent tapered reading with plastic gauge.*

1. Remove bearing cap and wipe oil from journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing, parallel to the crankshaft journal as shown.



72357

a - Gauging plastic
b - Journal

⚠ CAUTION

Avoid incorrect measurements. Bearing cap MUST be torqued to specification to ensure correct measurements. Variations in torque affect the compression of the plastic gauge. Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.

3. Install the bearing cap and evenly torque the main bearing cap bolt or stud to specifications.

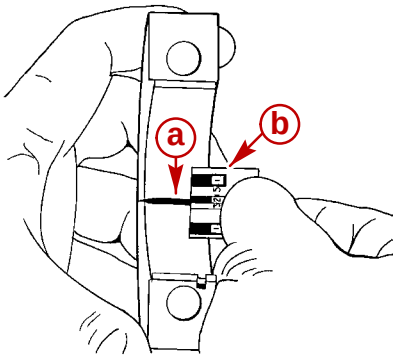
Description		Nm	lb-in.	lb-ft
Crankshaft main bearing cap bolt and stud - preferred method				
2 bolt type cap	First Pass	20		15
	Final pass	+ 73 degrees		
4 bolt type cap	First pass - inboard and outboard bolts and studs	20		15
	Final pass - outboard bolt	+ 43 degrees		
	Final pass - inboard bolt and stud	+ 73 degrees		
Crankshaft main bearing cap bolt and stud - optional method				
2 bolt type cap	One pass - all bolts evenly tightened	105		77
4 bolt type cap	One pass - all inboard bolts evenly tightened	105		77
	One pass - all outboard bolts evenly tightened	90		66

4. Remove bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or journal.
5. On the edge of the gauging plastic envelope there is a graduated scale that is correlated in thousandths of an inch. Without removing the gauging plastic, measure its compressed width (at the widest point) with the graduated scale.

NOTE:*Normally main bearing journals wear evenly and are not out of round.*

- *if a bearing is being fitted to an out of round journal of 0.0254 mm (0.001 in.) maximum, be sure to fit to the maximum diameter of the journal.*
- *If the bearing is fitted to the minimum diameter and the journal is out of round 0.0254 mm (0.001 in.), interference between the bearing and journal will result in rapid bearing failure.*
- *If the flattened gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal.*

- *Measure the journal with a micrometer if the flattened gauging plastic indicates more than .0254 mm (.001 in.) difference.*



72358

a - Compressed gauging plastic
b - Graduated scale

Main Bearing Clearance

Description		5.0 liter (305 CID) / 5.7 liter (350 CID)
Production	Number 1	0.018-0.053 mm (0.0007-0.0021 in.)
	Number 2, 3, 4	0.030-0.068 mm (0.0012-0.0027 in.)
	Number 5	0.020-0.060 mm (0.0008-0.0024 in.)
Service	Number 1	0.025-0.051 mm (0.0010-0.0020 in.)
	Number 2, 3, 4	0.025-0.064 mm (0.0010-0.0025 in.)
	Number 5	0.038-0.063 mm (0.0015-0.0025 in.)

Description		6.2 liter (377 CID)
Production	Number 1	0.018-0.053 mm (0.0007-0.0021 in.)
	Number 2, 3, 4	0.022-0.061 mm (0.00087-0.0024 in.)
	Number 5	0.025-0.069 mm (0.00098-0.0027 in.)
Service	Number 1	0.025-0.051 mm (0.00098-0.0020 in.)
	Number 2, 3, 4	0.025-0.064 mm (0.00098-0.0025 in.)
	Number 5	0.038-0.076 mm (0.00149-0.0030 in.)

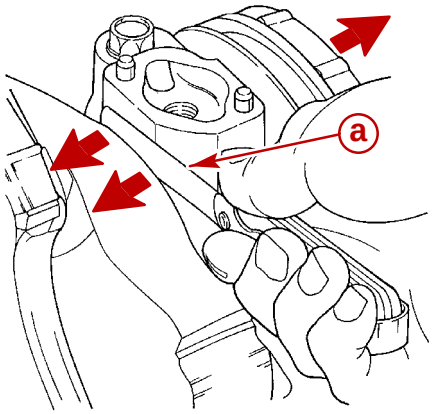
6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
7. A standard or 0.025 mm (0.001 in.) undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.

IMPORTANT: After selecting new bearing, recheck clearance.

8. Check clearance with newly selected bearing. If the bearing clearance is within specifications, the bearing insert is satisfactory. If not, repeat previous steps.
9. Proceed to the next bearing. After all bearings have been checked, rotate the crankshaft to check for excessive drag.

CRANKSHAFT END PLAY

1. Firmly force the crankshaft rearward.
2. Firmly force the crankshaft forward.
3. Measure clearance at the front end of the rear main bearing with a feeler gauge as shown.



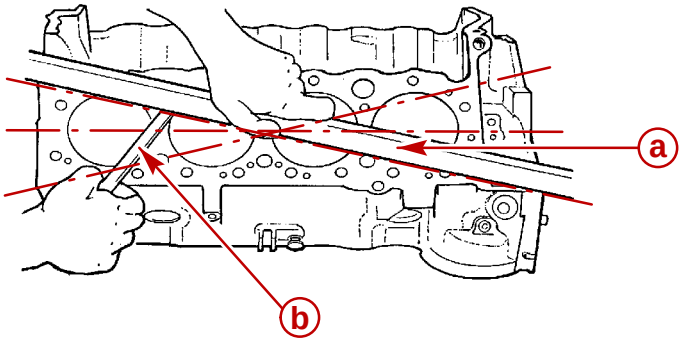
72360

a - Feeler gauge

Description	5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
End play (thrust clearance)	0.05-0.20 mm (0.0020-0.0079 in.)

ENGINE BLOCK

1. Inspect the engine block for cracks in coolant jackets.
2. Inspect the cylinder bores for scratches or gouging.
3. Inspect the valve lifter bores for excessive scoring or wear.
4. Inspect the threaded holes, crankshaft bearing caps, bearing bores, and engine block core hole expansion plug bores for damage.
5. Inspect the engine block, engine mount bosses and crankshaft bearing webs for cracks or damage.
6. Check engine block head gasket surfaces for warp with a machinist's straight-edge and a feeler gauge. Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are warped more than specified, engine block must be resurfaced by a machine shop.



72388

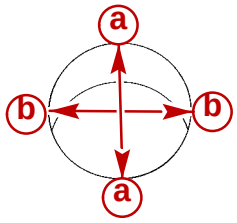
a - Machinist's straight-edge
b - Feeler gauge

Description		**5.0 liter (305 CID), 5.7 liter (350 CID) / 6.2 liter (377 CID)**
Cylinder head gasket surface flatness	Within An 152 mm (6 in.) Area	0.10 mm (0.0040 in.)

7. Measure cylinder walls for taper, out of round, and excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. Carefully move gauge up and down cylinder to determine taper. Turn gauge to different points around cylinder wall to determine out of round condition.

Taper is the difference between measurement "**a**" at top of cylinder bore and "**a**" measurement at bottom of cylinder bore.

Out of Round is the difference between "**a**" and "**b**".



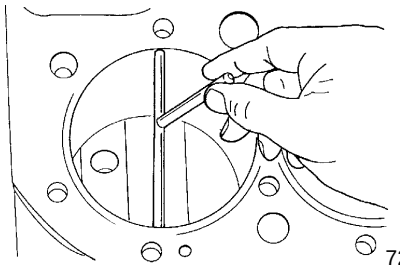
72385

Cylinder measurement points

a - At right angle to centerline of engine
b - Parallel to centerline of engine

Description	5.0 liter (305 CID)	5.7 liter (350 CID) / 6.2 liter (377 CID)
Diameter	94.894-94.947 mm (3.7360-3.7381 in.)	101.618-101.643 mm (4.0007-4.0017 in.)

8. If cylinder bore exceeds specifications, boring, and/or honing will be necessary.



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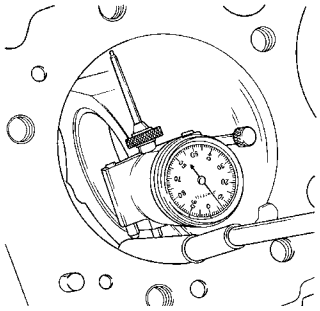


72387

Methods of measuring cylinder bore

Description		5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Out of round	Production	0.025 mm (0.0010 in.) maximum
	Service	0.05 mm (0.0020 in.) maximum
Taper	Production - thrust side	0.012 mm (0.0005 in.) maximum
	Production - relief side	0.025 mm (0.0010 in.) maximum
	Service limit	0.025 mm (0.0010 in.) over production

CYLINDER RECONDITIONING

NOTE:*Performance of the following operation depends upon engine condition at time of repair.*

NOTE:*If engine block inspection indicates that the block is suitable for continued use, out of round or tapered cylinders can be reconditioned by honing or boring.*

1. If cylinders have less than 0.127 mm (0.0050 in.) taper or wear, they can be conditioned with a hone and fitted with high limit standard size pistons. A cylinder bore of more than 0.127 mm (0.0050 in.) wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to bore for an oversize piston. If more than 0.127 mm (0.0050 in.) taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
2. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, lightly lubricate cylinder bores with engine oil and a clean cloth, and then wipe with a clean dry cloth.

CYLINDER BORING

IMPORTANT: Before using any type of boring bar, file top of engine block to remove dirt or burrs. This prevents boring bar tilt (the bored cylinder wall is not at right angles to crankshaft.)

1. File top of engine block to remove dirt and burrs.
2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

NOTE:*Hone cylinders as outlined under Cylinder Honing and Piston Selection.*

3. Carefully observe equipment manufacturer’s instructions.

CYLINDER HONING

1. Follow instructions provided by manufacturer.

Description	Part Number
Cylinder Hone Kit	J5902-01

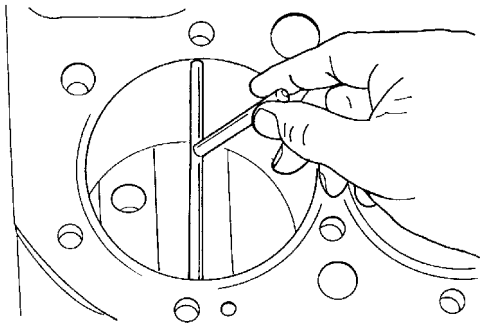
2. Occasionally, during the honing operation, clean the cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a cross hatch pattern of approximately 30 degrees to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles, and torn or folded metal.
4. Permanently mark piston for cylinder to which it has been fitted (refer to Piston Selection) and proceed to hone cylinders and fit remaining pistons.

IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size.

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings, cylinder bores and bearings lubricated by the contaminated oil. Lightly lubricate bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of engine block to remove excess material spread during honing operation.

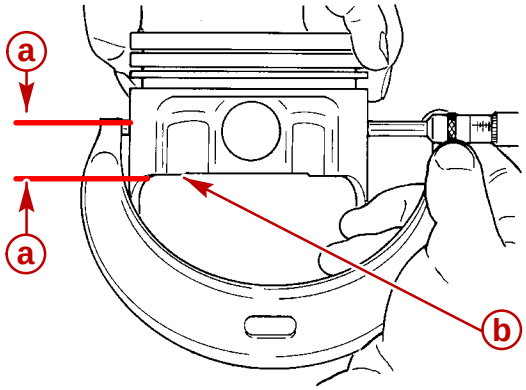
PISTON SELECTION

1. Check used piston to cylinder bore clearance as follows:
   a. Measure cylinder bore diameter with a telescope gauge 64 mm (2-1/2 in.) from top of cylinder bore.



72386

b. Measure piston diameter at skirt 11 mm (0.4331 in.) from the bottom of the skirt at a right angle to the piston pin bore.



72624

a - Measurement - 11 mm (0.4331 in.)
b - Bottom of skirt

c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.

d. Determine if piston bore clearance is in acceptable range.

Piston bore clearance

Description	5.0 liter (305 CID)	5.7 liter (350 CID)
Production	0.018-0.061 mm (0.0007-0.0024 in.)	0.018-0.053 mm (0.0007-0.0020 in.)
Service	0.018-0.068 mm (0.0007-0.0026 in.)	0.018-0.061 mm (0.0007-0.0024 in.)

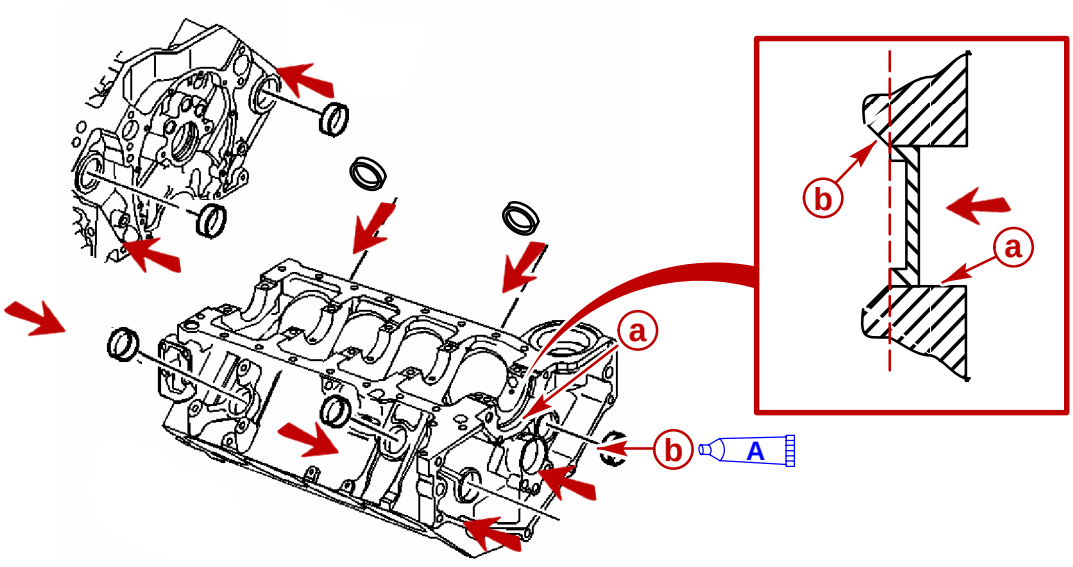
Description	6.2 liter (377 CID)
Production	0.018-0.053 mm (0.0007-0.0021 in.)
Service	0.018-0.068 mm (0.0007-0.0027 in.)

2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter, then hone cylinder bore to correct clearance.
4. Mark piston to identify cylinder for which it was fitted.

Installation

ENGINE BLOCK PLUGS

1. Apply sealant to the outside diameter of each new engine block core hole expansion plugs.
2. Install engine block core hole expansion plugs flush with the inside chamfer of the engine block core hole.



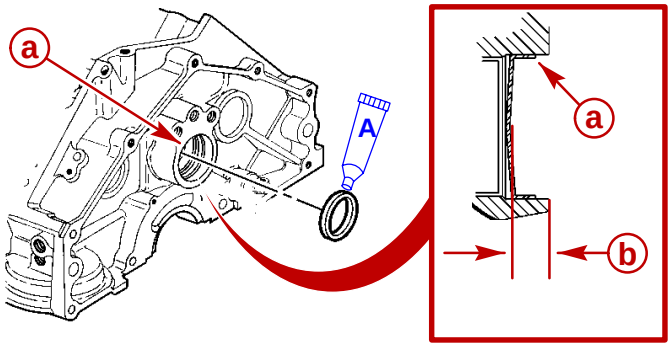
77894

a - Core hole
b - Inside chamfer

Description		Where Used	Part Number
A	Loctite 242 Threadlocker	Engine block core hole expansion plug	92-809821

3. Apply sealant to the outside diameter of the new camshaft rear bearing hole expansion cup plug.

4. Install the camshaft rear bearing hole expansion cup plug as indicated.

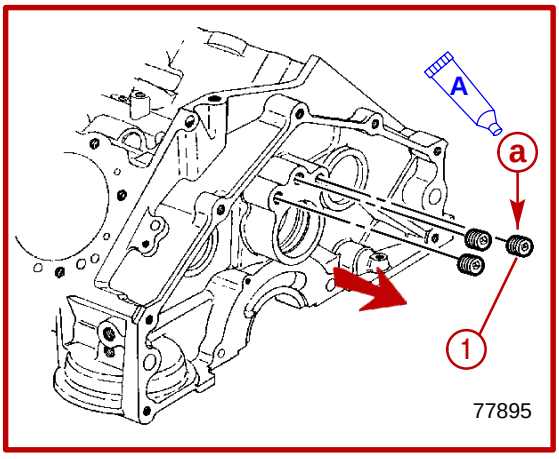


77893

a - Camshaft bearing hole
b - Measurement - 8.8 mm (0.3465 in.)

Description		Where Used	Part Number
A	Loctite 242 Threadlocker	Camshaft rear bearing hole expansion plug	92-809821

5. Apply sealant to the threads of the oil pressure sender and oil gallery plugs.
6. Install oil pressure sender and oil gallery plugs indicated.



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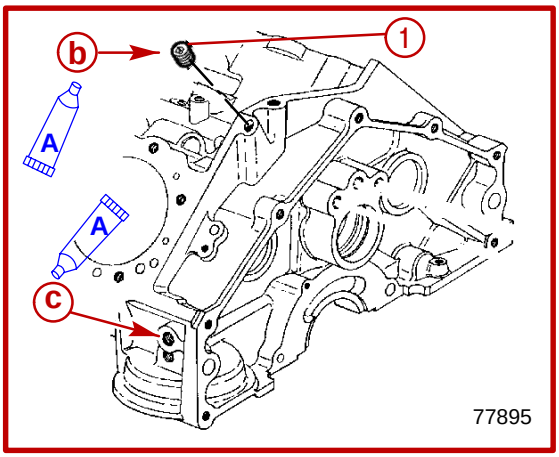


77895

a - Rear oil gallery plugs
b - Left rear top oil gallery plug
c - Oil pressure sender location

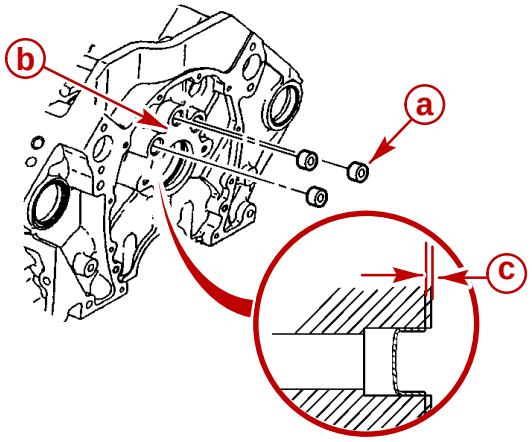
Description		Where Used	Part Number
A	Loctite 565 PST	Oil gallery plugs	Obtain locally
		Oil pressure sender	

Description		Nm	lb-in.	lb-ft
1	Oil Gallery Plug	20		15

7. Coat the threads of the new engine block oil gallery plugs with sealant.

Description	Where Used	Part Number
Loctite 565 PST	Oil gallery plug	Obtain locally

8. Install front oil gallery plugs less than flush with engine block front surface as indicated.



77892

a - Front oil gallery plugs
b - Engine block front surface
c - Measurement - 0.11 mm (0.004 in.)

9. Coat the threads of the engine block coolant drain plugs with sealant.

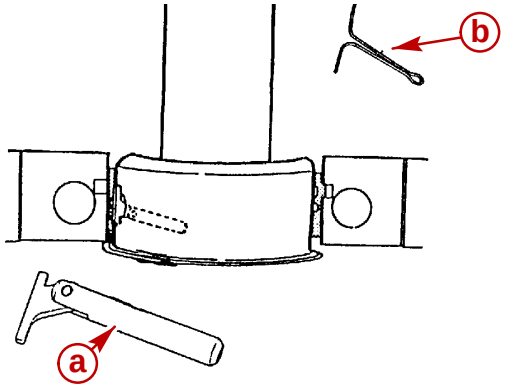
Description	Where Used	Part Number
Loctite 565 PST	Engine block coolant drain hole plug	Obtain locally

10. Install engine block coolant drain hole plugs. Torque plugs.

Description	Nm	lb-in.	lb-ft
Engine Block Coolant Drain Hole Plug	20		15

MAIN BEARINGS - WITHOUT CRANKSHAFT REMOVED

1. Remove the cap on the main bearing requiring replacement.
2. Remove the bearing from the cap.
3. Install the Main Bearing Remover And Installer in the oil hole in the crankshaft journal. If this tool is not available, a cotter pin may be bent as shown and used.



72622

a - Main Bearing Remover And Installer
b - Cotter pin

Description	Part Number
Main Bearing Remover And Installer	J8080

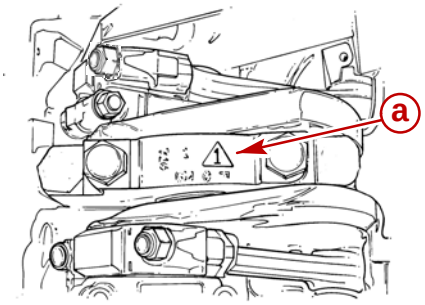
4. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll the upper bearing out of the engine block.
5. Lubricate a new upper bearing.

Description	Where Used	Part Number
Engine Oil	Upper bearing, lower bearing	Obtain locally

6. Insert the plain (unnotched) end between the crankshaft and the indented or notched side of the engine block.
7. Rotate the bearing into place and remove the tool from the oil hole in the crankshaft journal.
8. Lubricate a new lower bearing and install in bearing cap.

Description	Where Used	Part Number
Engine Oil	Upper bearing, lower bearing	Obtain locally

9. Install the main bearing cap in the original location with the markings pointing toward the front of the engine.



77467

a - Bearing cap marking

10. Torque all main bearing caps, EXCEPT the rear main bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft main bearing cap bolt and stud - preferred method				
2 bolt type cap	First pass	20		15
	Final pass	+ 73 degrees		
4 bolt type cap	First pass - inboard and outboard bolts and studs	20		15
	Final pass - outboard bolt	+ 43 degrees		
	Final pass - inboard bolt and stud	+ 73 degrees		
Crankshaft main bearing cap bolt and stud - optional method				
2 bolt type cap	One pass - all bolts evenly tightened	105		77
4 Bolt type cap	One pass - all inboard bolts evenly tightened	105		77
	One pass - all outboard bolts evenly tightened	90		66

11. Torque the rear main bearing cap.

a. **Preferred method :** Do first pass torque on rear main bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt and stud - preferred method				
2 bolt type cap	First pass	20		15
4 bolt type cap	First pass - inboard and outboard bolts and studs	20		15

b. **Preferred method :** Using a lead hammer, tap the end of the crankshaft to the rear.

c. **Preferred method :** Using a lead hammer, tap the end of the crankshaft to the front.

d. **Preferred method :** Do final pass torque on bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt and stud - preferred method				
2 bolt type cap	Final pass	+ 73 degrees		
4 bolt type cap	Final pass - outboard bolt	+ 43 degrees		
	Final pass - inboard bolt and stud	+ 73 degrees		

e. **Optional method :** Tap the end of the crankshaft to the rear and then to the front with a lead hammer.

f. **Optional method :** Evenly torque the rear main bearing cap to the specified amount.

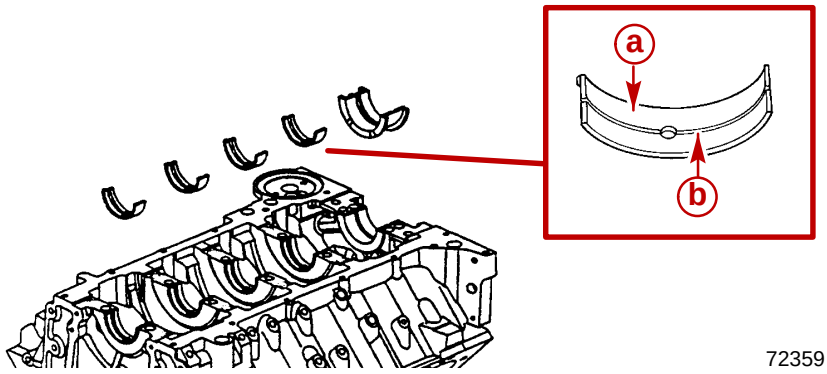
Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt and stud - optional method				
2 bolt type cap	One pass - all bolts evenly tightened	105		77
4 bolt type cap	One pass - all inboard bolts evenly tightened	105		77
	One pass - all outboard bolts evenly tightened	90		66

MAIN BEARINGS AND CRANKSHAFT

1. Remove timing sprocket from old crankshaft and reinstall on new crankshaft.
2. **On driveshaft extension models :** if old pilot bushing is to be reused, bushing can be removed without damage as follows.
   a. Fill pilot bushing cavity with grease,
   b. Insert an old transmission input shaft in bore of bushing and hit it with a hammer. This will create hydraulic pressure in pilot bushing cavity that should force bushing out.

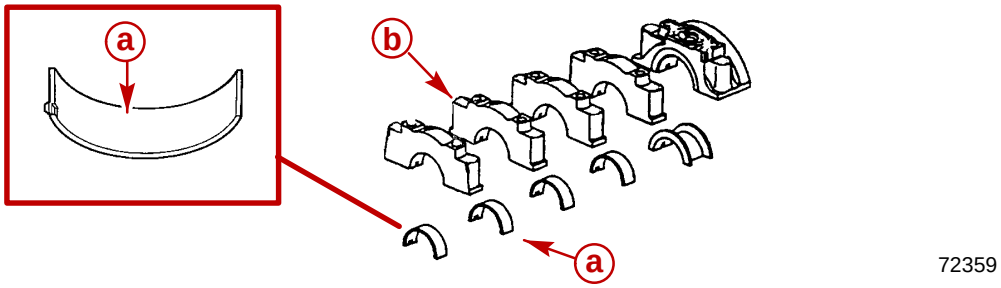
IMPORTANT: Ensure that all bearings and crankshaft journals are clean.

3. Install upper main bearing inserts in engine block.



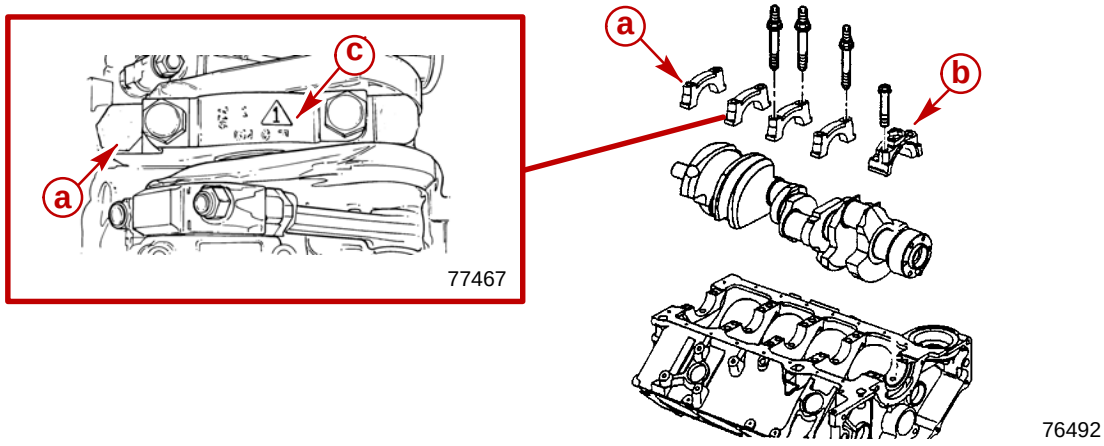
a - Upper insert
b - Oil groove

4. Install lower main bearing insert in main bearing caps.



a - Lower insert
b - Main bearing cap

5. Carefully lower crankshaft into place. Be careful not to damage bearing surfaces.
6. Install main bearing cap in original location with markings pointing toward front of engine.



a - Main bearing cap
b - Rear main bearing cap
c - Bearing cap marking

7. Verify clearance of each main bearing, following procedure outlined under Inspection - Main Bearing Clearance.
8. Lubricate the main bearings and crankshaft bearing journals.

Description	Where Used	Part Number
Engine Oil	Main bearings and crankshaft bearing journals	Obtain locally

9. Install main bearing caps.
10. Torque all main bearing caps, except the rear main cap, to specifications.

Description		Nm	lb-in.	lb-ft
Crankshaft main bearing cap bolt and stud - preferred method				
2 bolt type cap	First pass	20		15
	Final pass	+ 73 degrees		
4 bolt type cap	First pass - inboard and outboard bolts and studs	20		15
	Final pass - outboard bolt	+ 43 degrees		
	Final pass - inboard bolt and stud	+ 73 degrees		
Crankshaft main bearing cap bolt and stud - optional method				
2 bolt type cap	One pass - all bolts evenly tightened	105		77
4 bolt type cap	One pass - all inboard bolts evenly tightened	105		77
	One pass - all outboard bolts evenly tightened	90		66

11. Torque the rear main bearing cap.

a. **Preferred method:** Do first pass torque on rear main bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt and stud - preferred method				
2 bolt type cap	First pass	20		15
4 bolt type cap	First pass - inboard and outboard bolts and studs	20		15

b. **Preferred method:** Using a lead hammer, tap the end of the crankshaft to the rear.

c. **Preferred method:** Using a lead hammer, tap the end of the crankshaft to the front.

d. **Preferred method:** Do final pass torque on bearing cap.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt and stud - preferred method				
2 bolt type cap	Final pass	+ 73 degrees		
4 bolt type cap	Final pass - outboard bolt	+ 43 degrees		
	Final pass - inboard bolt and stud	+ 73 degrees		

e. **Optional method :** Tap the end of the crankshaft to the rear and then to the front with a lead hammer.

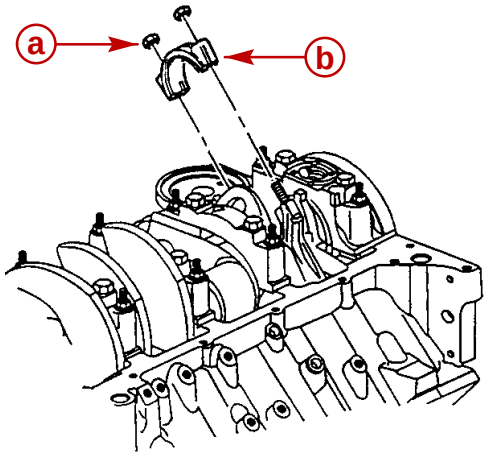
f. **Optional method :** Evenly torque the rear main bearing cap to the specified amount.

Description		Nm	lb-in.	lb-ft
Crankshaft (main) bearing cap bolt and stud - optional method				
2 bolt type cap	One pass - all bolts evenly tightened	105		77
4 bolt type cap	One pass - all inboard bolts evenly tightened	105		77
	One pass - all outboard bolts evenly tightened	90		66

12. Check crankshaft end play.
13. Install rear main seal retainer and seal.
14. Verify clearance for each connecting rod bearing, following procedure under Connecting Rod, Bearings, and Piston Assembly - Inspection.
15. Coat the connecting rod bearing surface with lubricant.

Description	Where Used	Part Number
Engine Oil	Connecting rod bearing surfaces	Obtain locally

16. Install the connecting rod cap.
17. In a two pass sequence, torque connecting rod cap nuts.



76716

a - Connecting rod nut
b - Connecting rod cap

Description		Nm	lb-in.	lb-ft
Connecting rod nut - 5.0 liter (305 CID) and 5.7 liter (350 CID)				
	First Pass	27		20
	Final Pass (Angle Torque)	+ 70 degrees		
Connecting rod nut - 6.2 liter (377 CID)				
	First Pass	27		20
	Final Pass (Angle Torque)	+ 45 degrees		

18. Install timing chain.

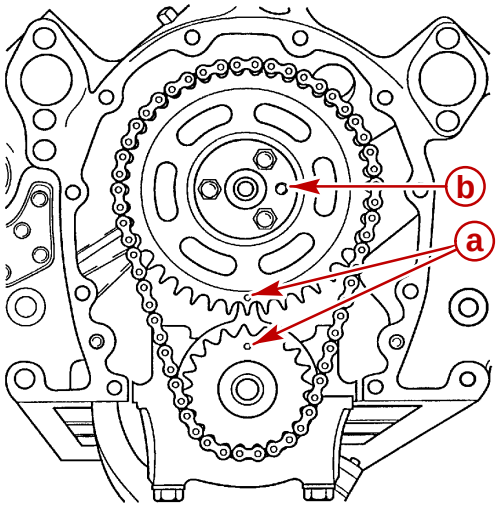
IMPORTANT: Crankcase front cover is not reusable per manufacturer's specification. It must be replaced if removed.

19. Install new front cover and gasket.
20. Install oil pump and crankshaft oil deflector.
21. Install dipstick tube and oil pan.
22. Install spark plugs.
23. Install crankshaft balancer and crankshaft pulley.
24. Install water circulating pump.
25. Install serpentine belt.
26. Install flywheel and drive coupler / plate.
27. Install flywheel housing.
28. Install starter.
29. Install new oil filter.
30. Fill crankcase with oil.
31. Install engine in boat.

Timing Chain And Sprockets

Removal

1. Remove the serpentine belt.
2. Remove the water circulating pump.
3. Remove crankshaft balancer.
4. Remove oil pan.
5. Remove the front cover.
6. Remove the crankshaft position sensor reluctor ring.
7. Turn crankshaft to align timing mark with camshaft mark or turn crankshaft to cylinder number 1 TDC and mark both gears for alignment in reassembly.



72376

Typical

a - Alignment marks
b - Locating pin

8. Remove timing chain.
9. Remove camshaft sprocket.

NOTE:*If sprocket does not come off easily, a light tap on the lower edge of the sprocket with a plastic mallet should dislodge it.*

10. Remove crankshaft sprocket using Crankshaft Gear Remover.

Description	Part Number
Crankshaft Gear Remover	J5825-A

Cleaning

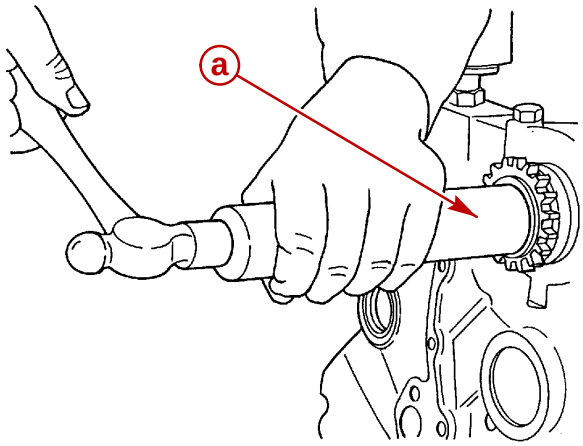
1. Clean all parts in solvent.
2. Dry with compressed air.

Inspection

1. Inspect timing chain for wear and damage.
2. Inspect sprockets for wear and damage.

Reassembly

1. Install the sprocket on the crankshaft by using the Rear Pinion Bearing Race Installer Tool.



72377

a - Rear Pinion Bearing Race Installer Tool

Description	Part Number
Rear Pinion Bearing Race Installer	J5590

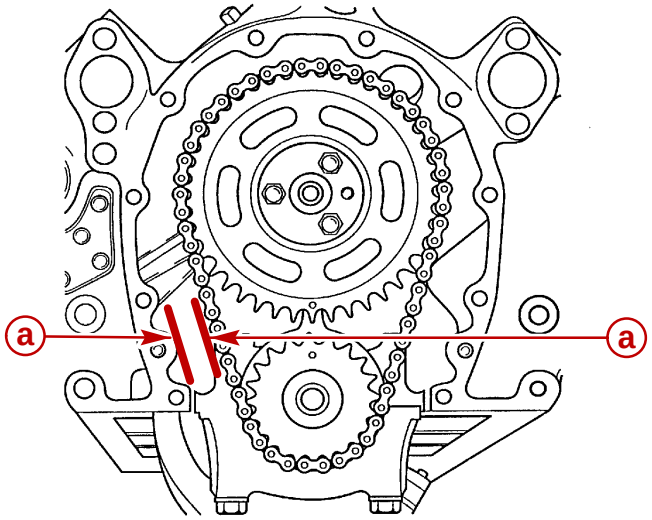
2. Align the marks on the crankshaft and the camshaft sprockets.
3. Install camshaft sprocket and timing chain. Torque sprocket bolts.

Description	Nm	lb-in.	lb-ft
Camshaft sprocket bolt	25		18

CHECKING TIMING CHAIN DEFLECTION

1. Rotate camshaft (in either direction) to place tension on one side of the chain.
2. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
3. Rotate camshaft in the opposite direction to slacken the chain, then force chain out with fingers and again measure the distance between reference point and timing chain.

4. The deflection is the difference between these 2 measurements. If the deflection exceeds specification, timing chain should be replaced.



72376

a - Reference point

Description	**5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)**
Chain deflection	11 mm (0.43 in.) maximum

Installation

1. Install the crankshaft position sensor reluctor ring.

IMPORTANT: The front cover is not reusable per manufacturer's specification. It must be replaced if removed.

2. Install new front cover and gasket.
3. Install oil pan.
4. Install crankshaft balancer.
5. Install the water circulating pump.
6. Install the serpentine belt.

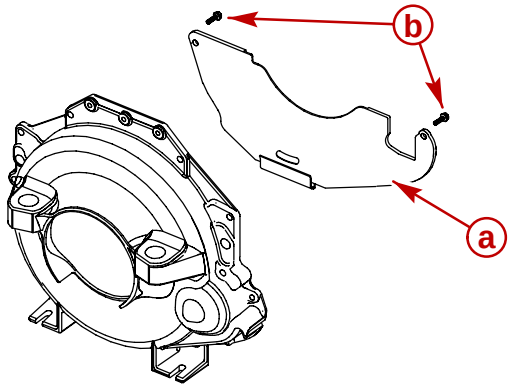
Flywheel Housing

Removal

1. **MCM models**: Remove sterndrive.
2. Remove engine from boat.
3. **MIE models:** Remove transmission.

IMPORTANT: Use caution when removing water hoses; Do not bend ends of power steering cooler.

4. Remove water hoses from power steering cooler if equipped.
5. **MIE models:** Remove rear mounted starter, if equipped.
6. Remove power steering cooler if equipped.
7. Remove flywheel housing cover.



00000

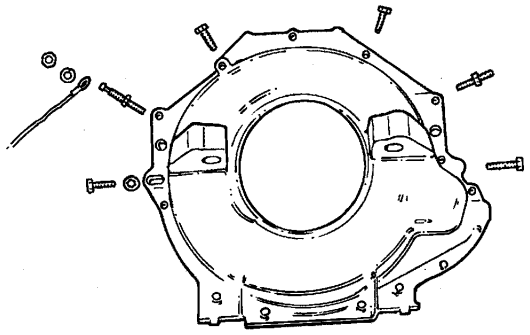
MCM shown, MIE similar

a - Flywheel housing cover
b - Screws

8. Remove ground wires from flywheel housing.

IMPORTANT: Flywheel housing bolts must be installed in same location as removed.

9. Remove the bolts and studs from the flywheel housing.
10. Remove the flywheel housing.



77444

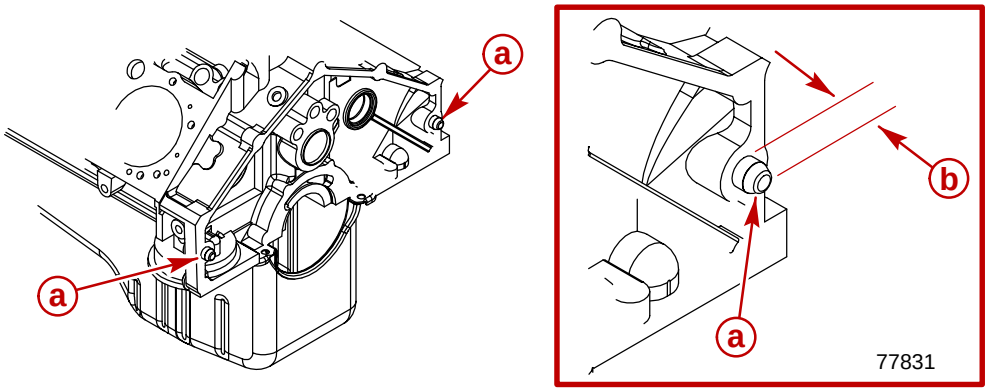
MCM shown, MIE similar

Cleaning

1. Clean all parts in cleaning solvent.
2. Dry with compressed air.

Inspection

1. Inspect flywheel housing for cracks, damaged bolt or stud holes, and excessive wear. Replace if necessary.
2. Inspect guide dowels for proper position. Repair if necessary.



a - Guide dowel
b - Measurement - 13 mm (0.5 in.)

Installation

1. Align flywheel housing onto guide dowels on engine.

IMPORTANT: Flywheel housing fasteners must be installed in same location as removed.

2. Install studs and bolts in the original locations.
3. Torque flywheel housing studs and bolts.

Description	Nm	lb-in.	lb-ft
Flywheel housing stud and bolt	41		30

4. Install flywheel housing cover.

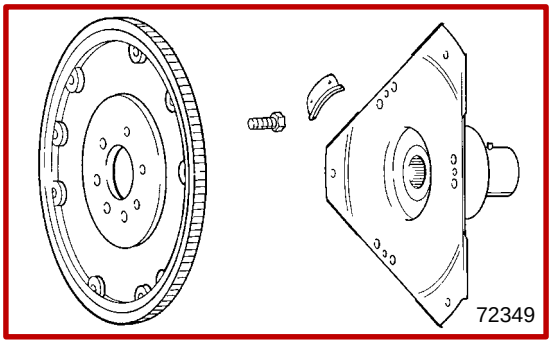
Description	Nm	lb-in.	lb-ft
Flywheel housing cover	9	80	

5. Install the ground wires.
6. Install power steering cooler, if equipped.
7. Install water hoses.
8. **MIE models:** Install the transmission and the rear mounted starter, if equipped.
9. Install the power package in the boat.

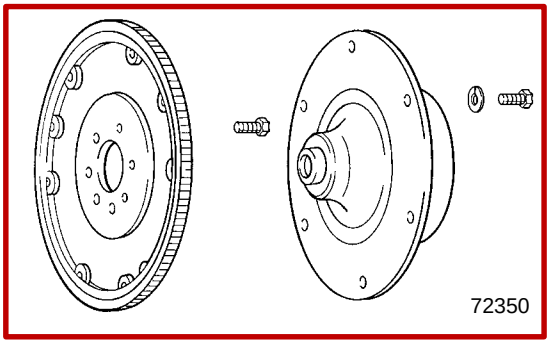
Flywheel

Removal

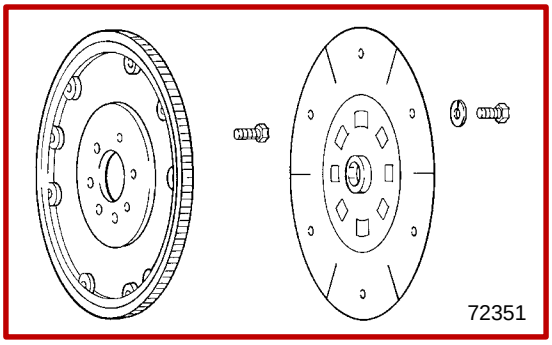
1. **MCM models:** Remove sterndrive.
2. Remove engine from boat.
3. **MIE models:** Remove transmission.
4. Remove flywheel housing.
5. Remove coupler or drive plate.



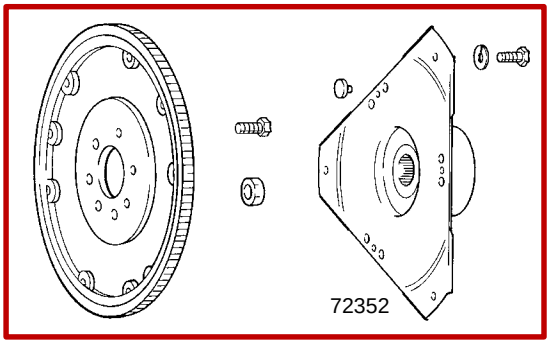
Alpha coupler



Bravo coupler

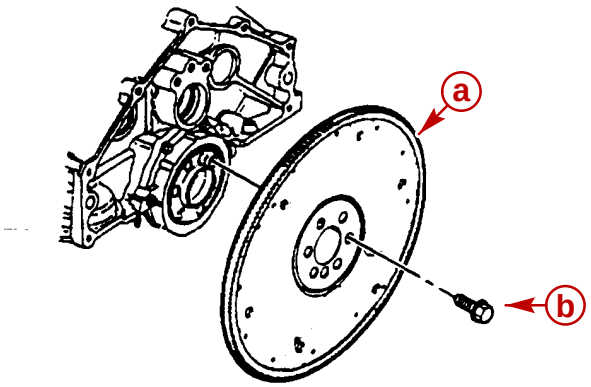


MIE drive plate



Drive Shaft Extension coupler

6. Remove the flywheel.



76490

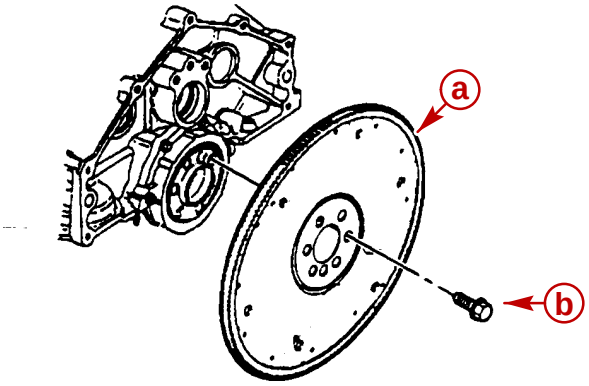
a - Flywheel
b - Bolts

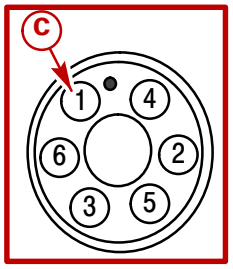
Cleaning and Inspection

1. Clean mating surfaces of flywheel and crankshaft. Remove any burrs. Mating surfaces must be clean, bare metal.
2. Check flywheel ring gear for worn and missing teeth.
3. Inspect splines in drive plate or coupler for wear.

Installation

1. Align dowel hole in flywheel with dowel in crankshaft.
2. Install flywheel.
3. Install flywheel bolts. Torque bolts in sequence.



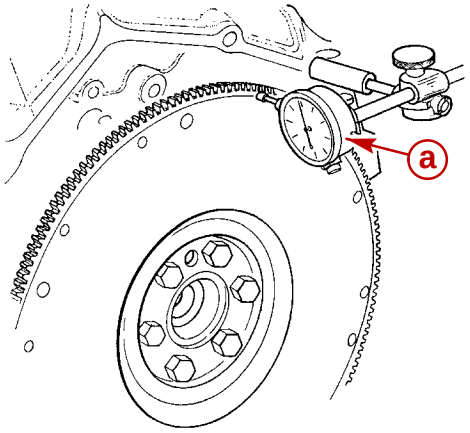


76490

a - Flywheel
b - Bolt
c - Numbered sequence

Description	Nm	lb-in.	lb-ft
Engine flywheel bolt	100		74

4. Check flywheel runout as follows:
   a. Attach a dial indicator to engine block. Take measurement around outer edge of flywheel.
   b. Push in on flywheel to remove crankshaft end play.
   c. Turn flywheel and measure runout.

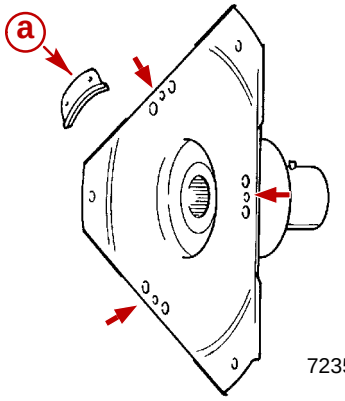


72353

a - Dial Indicator

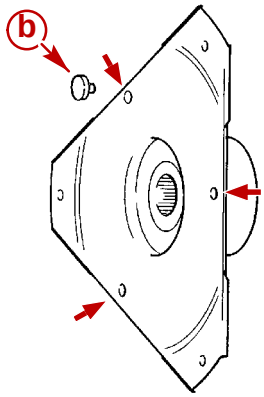
Description	5.0 liter (305 CID) / 5.7 liter (350 CID) / 6.2 liter (377 CID)
Runout	0.203 mm (0.0080 in.) maximum

5. If equipped, insert rubber bumpers in coupler before installation on flywheel.



72352

Alpha coupler



72354

Drive Shaft Extension coupler

a - Alpha coupler rubber bumper (3)
b - Drive shaft extension coupler rubber bumper (3)

6. Install coupler or drive plate. Torque bolts.

Description	Nm	lb-in.	lb-ft
Coupler to flywheel bolts (MCM)	48		35
Drive plate to flywheel bolts (MIE)			

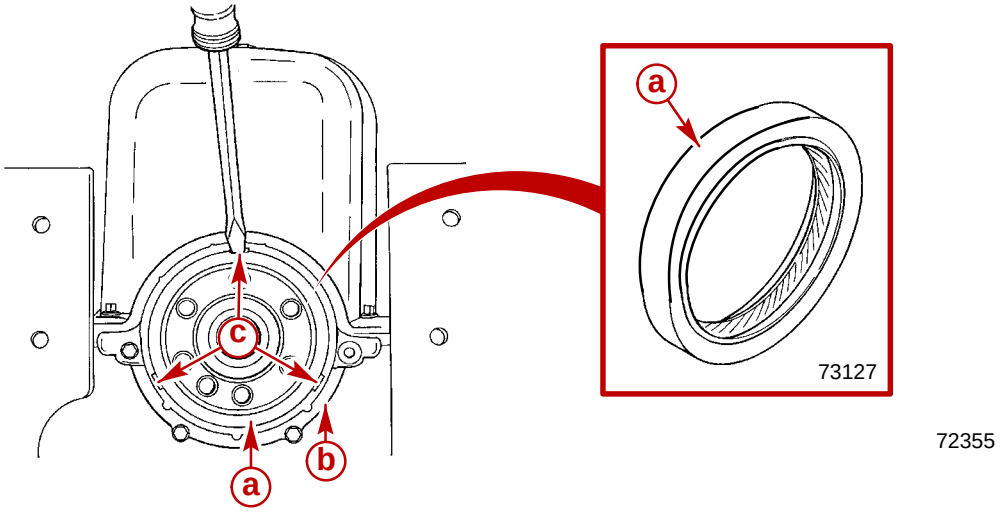
7. Install flywheel housing.
8. **MIE models:** Install transmission.
9. Install the power package in the boat.

Rear Oil Seal

The rear crankshaft oil seal can be replaced without removing the oil pan or rear main bearing cap from engine.

Removal

1. Remove the flywheel.
2. Remove rear oil seal by using a screwdriver to pry it out of the seal retainer.



a - Oil seal
b - Seal retainer
c - Slots (3)

Cleaning

1. Clean crankshaft sealing surface.
2. Clean the rear oil seal retainer bore.

Inspection

1. Inspect seal retainer bore for nicks and burrs. Minor imperfections may be removed with a fine grade emery cloth.
2. Inspect crankshaft sealing area for nicks, burrs, and scoring.
3. Inspect the outside diameter of the engine flywheel pilot flange for imperfections or rust. Minor imperfections and/or rust may be removed with a fine grade emery cloth.

Installation

1. Lightly lubricate the bore of the rear oil seal retainer.

Description	Where Used	Part Number
Engine Oil	Bore of rear oil seal	Obtain locally

2. Lightly lubricate the outside diameter of the flywheel pilot flange.

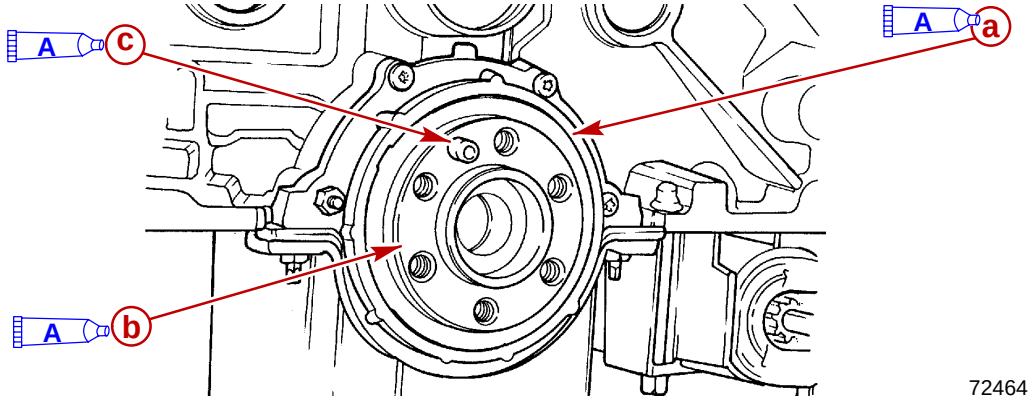
Description	Where Used	Part Number
Engine Oil	Outer diameter of flywheel pilot flange	Obtain locally

3. Lightly lubricate the outside diameter of the flywheel locator pin.

Description	Where Used	Part Number
Engine Oil	Outer diameter of flywheel locator pin	Obtain locally

4. Lightly lubricate the outer diameter of the rear oil seal.

Description	Where Used	Part Number
Engine Oil	Outer diameter of rear oil seal	Obtain locally



72464

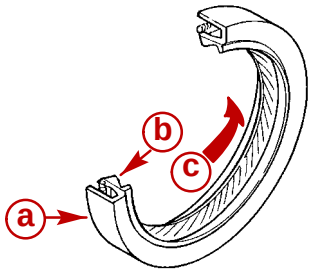
a - Retainer bore
b - Flywheel pilot flange
c - Flywheel locator pin

Description		Where Used	Part Number
A	Engine Oil	Bore of rear oil seal retainer, OD of flywheel pilot flange, OD of flywheel locator pin, OD of rear oil seal	Obtain locally

5. Remove the installation guide from the new crankshaft rear oil seal.
6. Lightly lubricate the outside diameter of the new crankshaft rear oil seal.

Description	Where Used	Part Number
Engine Oil	Outer diameter of rear oil seal	Obtain locally

7. Install the new crankshaft rear oil seal onto the Rear Main Oil Seal Installer.



73127

a - Rear oil seal
b - Seal lip toward inside of engine
c - Rotation of crankshaft as viewed from flywheel end looking forward

Description	Part Number
Rear Main Seal Installer	J35621-B

8. Install the Rear Oil Seal Installer onto the rear of the crankshaft and tighten the tool bolts until they contact.

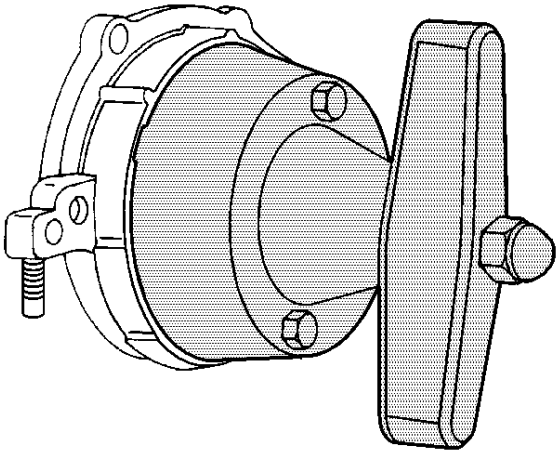
IMPORTANT: Do not allow oil or other lubricants to contact the rear oil seal surface.

⚠ CAUTION

Proper alignment of the crankshaft rear oil seal is critical. Install the rear oil seal near to flush and square to the rear oil seal retainer. Failing to do so may cause the rear oil seal or the Rear Oil Seal Installer tool to fail.

9. Install the rear oil seal by turning the Rear Oil Seal Installer wing nut CLOCKWISE until the rear oil seal is almost flush with and evenly seated in the rear oil seal retainer.
10. Turn the Rear Oil Seal Installer wing nut COUNTERCLOCKWISE to release the Rear Oil Seal Installer from the rear oil seal.

11. Remove the Rear Oil Seal Installer from the crankshaft.



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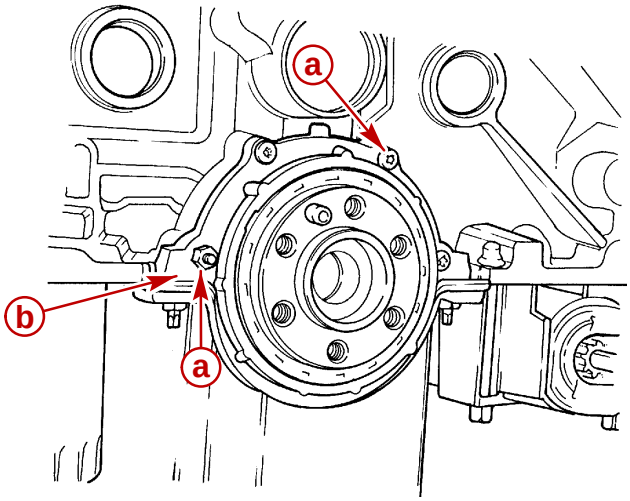
12. Wipe off any excess engine oil with a clean rag.

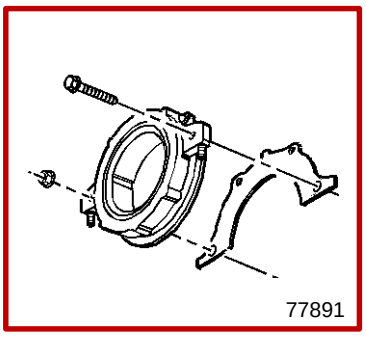
Rear Oil Seal Retainer

The rear oil seal retainer can only be replaced with the oil pan removed.

Removal

1. Remove oil pan.
2. Remove oil seal retainer fasteners.
3. Remove oil seal retainer.





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72464

a - Fasteners
b - Oil seal retainer

4. Remove and discard the old gasket.

Cleaning

1. Clean all sealing surfaces.
2. Wash all parts in solvent and dry with compressed air.

Inspection

1. Inspect oil seal retainer for cracks or scored surface.
2. Inspect oil seal for worn, dry, or torn rubber. Replace if necessary.
3. Inspect flywheel locator pin for damage. Replace if necessary.

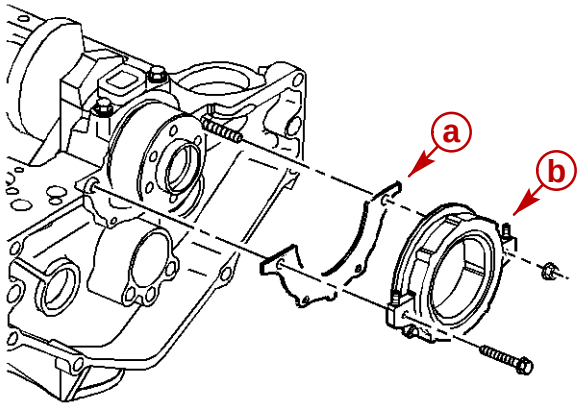
Installation

IMPORTANT: Always use a new oil seal retainer gasket when installing the crankshaft rear oil seal retainer.

1. Install the rear oil seal retainer stud, if removed previously. Torque stud.

Description	Nm	lb-in.	lb-ft
Rear oil seal retainer stud	6	53	

2. Install new rear oil seal retainer gasket.
3. Install the rear oil seal retainer on the stud.



77891

a - Oil seal retainer gasket
b - Rear oil seal retainer

4. Install retainer nut and bolts. Torque nut and bolts.

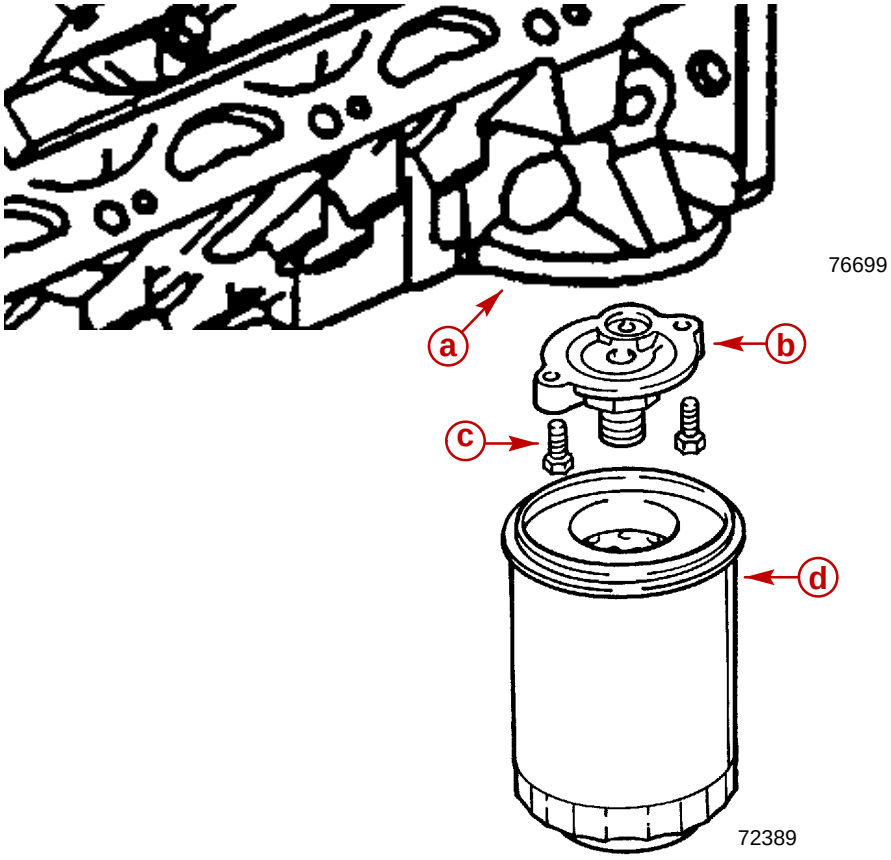
Description	Nm	lb-in.	lb-ft
Rear oil seal retainer nut and bolts	12	106	

5. If not already installed, install the rear oil seal.
6. Install the oil pan.

Oil Filter, By-Pass Valve, and Block Adapter

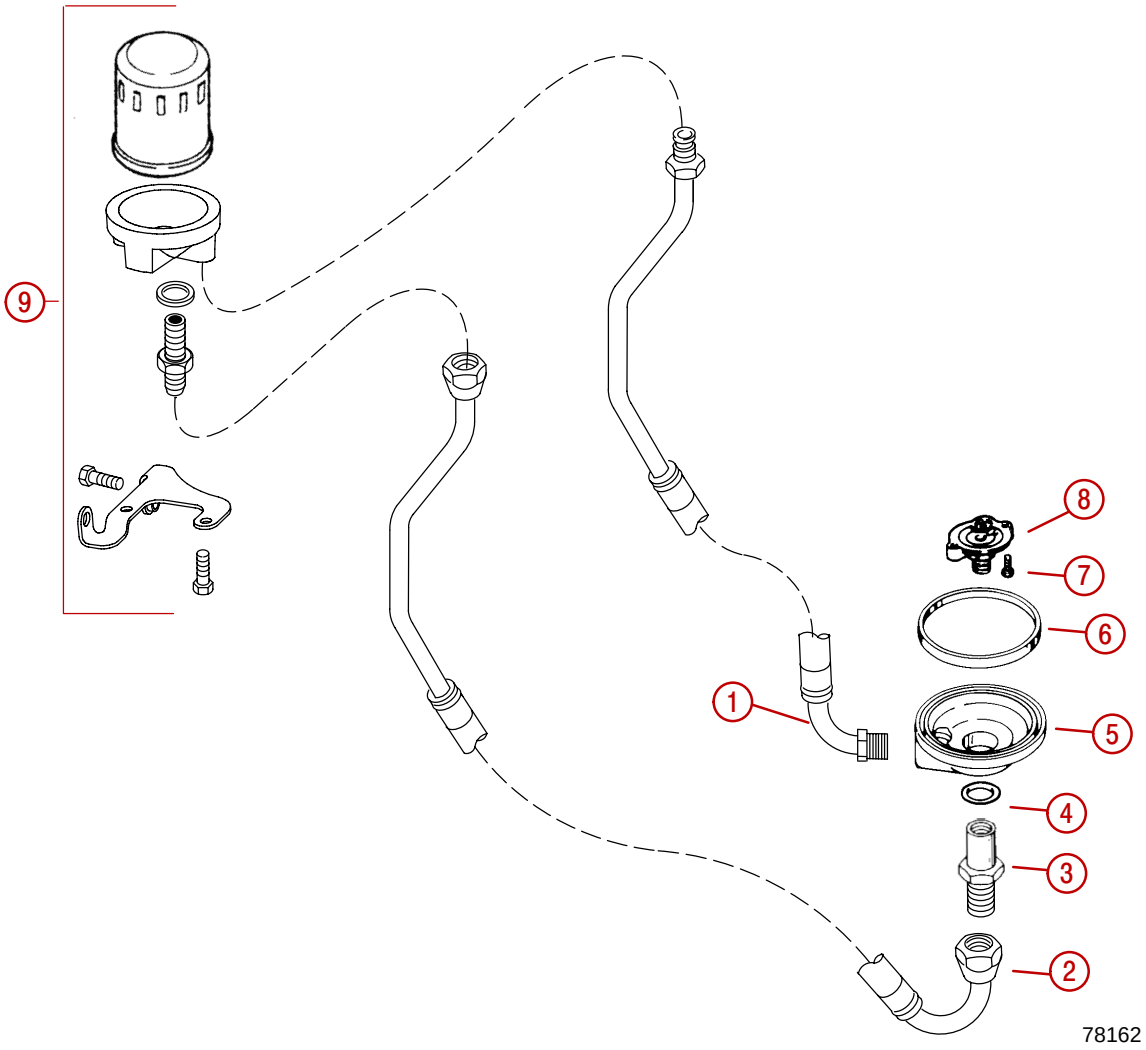
IMPORTANT: Oil filter by-pass valve and block adapter assembly should be inspected whenever the engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

Oil Filter And Block Adapter Assembly For Engine Block Applications



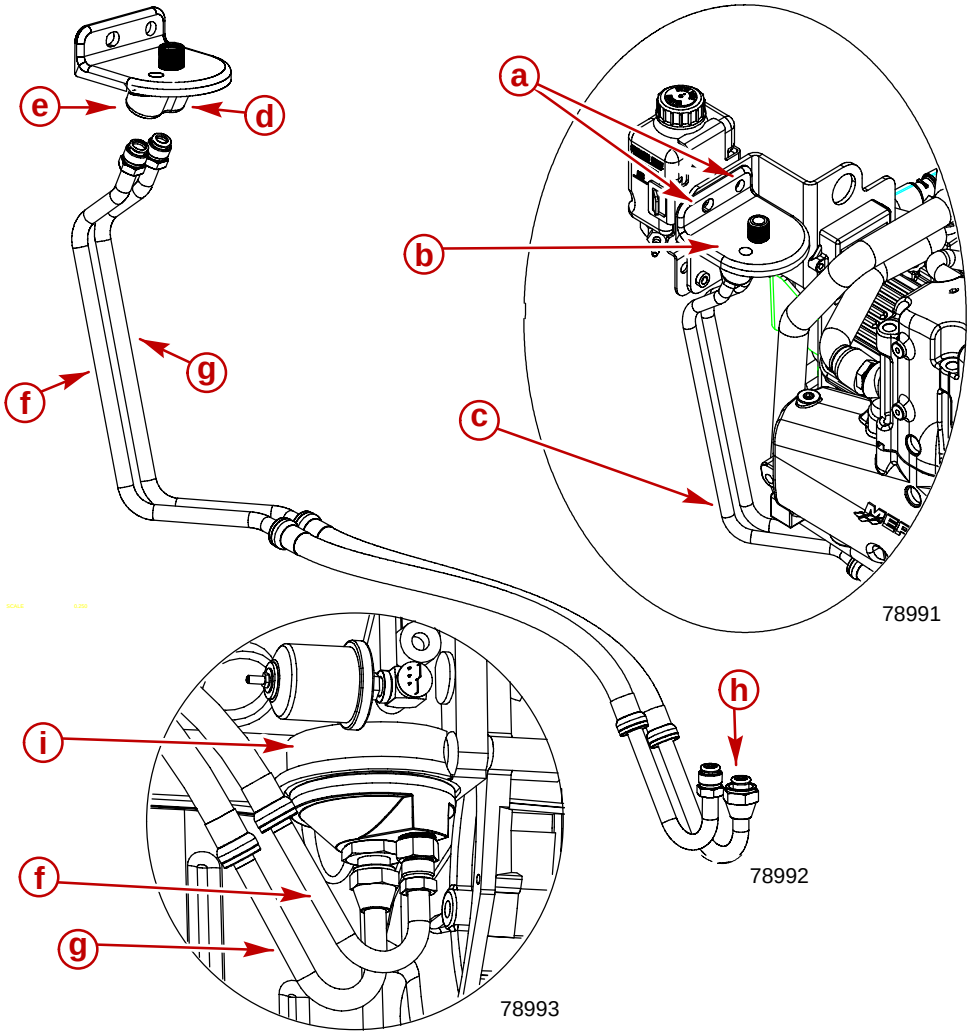
a - Engine block
b - Block adapter and by-pass valve
c - Bolt (2)
d - Oil filter

Remote Oil Filter Assembly For Front Bracket Applications



1 - Oil line
2 - Oil line
3 - Fitting / bushing
4 - Quad ring seal
5 - Oil filter adapter
6 - Seal
7 - Bolt
8 - Block adapter and by-pass valve
9 - Remote oil filter and components

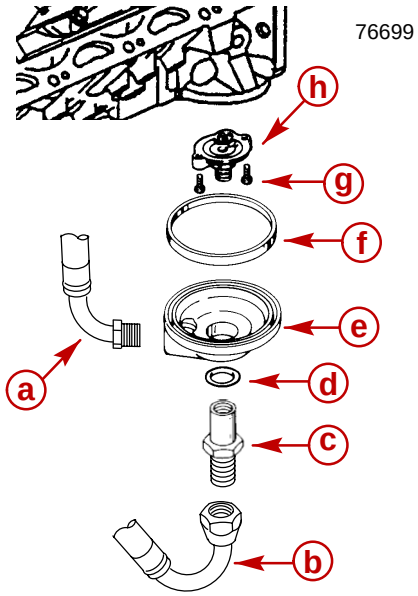
Remote Oil Filter Assembly For Front Lifting Eye Bracket Applications



- **a** - Remote oil filter bracket bolts
- **b** - Remote oil filter bracket
- **c** - Position of oil lines
- **d** - Center threaded port of oil filter bracket
- **e** - Outer threaded port of oil filter bracket
- **f** - Remote oil return line
- **g** - Remote oil delivery line
- **h** - Remote oil delivery line female fitting
- **i** - Block adapter and by-pass valve

Removal

1. Remove oil line from oil filter adapter.
2. Remove oil line from fitting / bushing.
3. Remove fitting / bushing and quad ring seal. Discard quad ring seal.
4. Remove oil filter adapter and seal. Discard seal.
5. Remove block adapter with by-pass valve.



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Typical

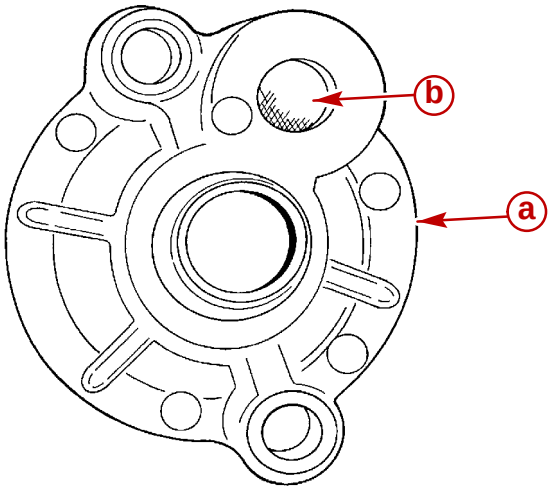
- **a** - Filter adapter oil line
- **b** - Fitting / bushing oil line
- **c** - Fitting / bushing
- **d** - Quad ring seal
- **e** - Oil filter adapter
- **f** - Seal
- **g** - Bolt
- **h** - Block adapter with by pass valve

Cleaning

1. Clean by-pass valve and block adapter assembly in solvent.
2. Dry with compressed air.
3. Clean fitting / bushing and oil filter adapter in solvent.
4. Dry with compressed air.

Inspection

1. Inspect the block adapter for cracks, thread wear, or other damage.
2. Inspect by-pass (fiber) valve for cracks or other damage.
3. Ensure that by-pass valve fits tightly against its seat.
4. Push by-pass valve down and release it. By-pass valve should return freely to its original position. If by-pass valve operation is questionable, replace the block adapter assembly.



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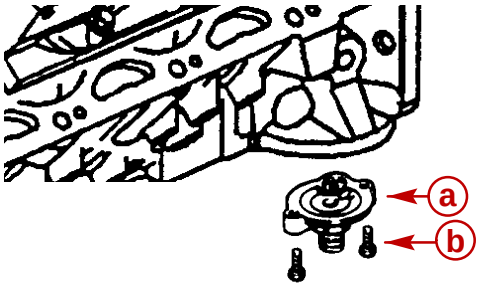
Typical block adapter assembly with by-pass valve

a - Block adapter assembly
b - By-pass (fiber) valve

5. Inspect the oil filter adapter and fitting/bushing for cracks, thread wear, or other damage.

Installation

1. Install block adapter with by-pass valve on engine block. Torque bolts.



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a - Block adapter
b - Bolt (2)

Description	Nm	lb-in.	lb-ft
By-pass valve block adapter bolt	27		20

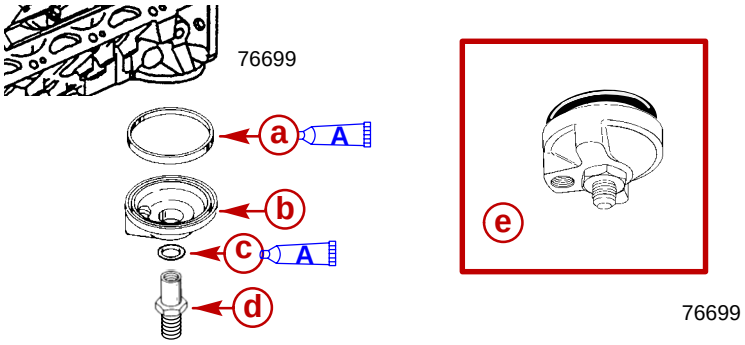
2. Place a new seal in the oil filter adapter and lightly lubricate the sealing surfaces.

Description	Where Used	Part Number
Engine Oil	Oil filter adapter sealing surface	Obtain locally

3. Install a new seal and oil filter adapter on engine block.
4. Lightly lubricate a new quad ring seal and place on the fitting / bushing.

Description	Where Used	Part Number
Engine Oil	Oil filter adapter quad ring seal	Obtain locally

5. Install fitting / bushing with quad ring seal. Torque fitting / bushing.



a - Seal
b - Oil filter adapter
c - Quad ring seal
d - Fitting / bushing
e - Oil filter adapter (later style)

Description		Where Used	Part Number
A	Engine Oil	Oil filter adapter, quad ring seal for oil filter adapter fitting / bushing	Obtain locally

Description	Nm	lb-in.	lb-ft
Oil filter adapter fitting / bushing	31		23

NOTE:*Ensure that the remote oil delivery line is connected to the fitting / bushing of the remote oil filter adapter and to the center port of the remote oil filter assembly.*

6. Install and torque oil lines on fitting / bushing and adapter.

Description	Nm	lb-in.	lb-ft
Oil lines	27		20

NOTES:

ELECTRICAL SYSTEM

Section 4A - Starting System

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4 A

Models Covered

Delco PG260G1

STERNDRIVE (MCM)

Model	Serial Number or Year
5.0L Alpha and Bravo	0M087348 and Above
5.7L Alpha and Bravo	
5.0L MPI Alpha and Bravo	0M300000 and Above
350 MAG MPI Alpha and Bravo	
350 MAG MPI Alpha and Bravo Horizon	
MX 6.2 MPI	
MX 6.2 MPI Horizon	

TOW SPORTS (MIE)

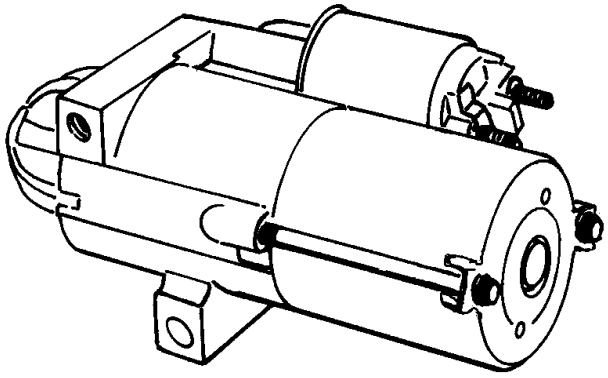
Model	Serial Number or Year
350 MAG MPI	0M310000 and Above
Black Scorpion	0M391600 and Above
MX 6.2 MPI	0M310000 and Above
MX 6.2 Black Scorpion	0M391750 and Above

Delco PG260L

INBOARD (MIE)

Model	Serial Number or Year
5.7L	0M640000 and Above
350 MAG MPI	0M310000 and Above
350 MAG MPI Horizon	
MX 6.2 MPI	
MX 6.2 MPI Horizon	

Identification



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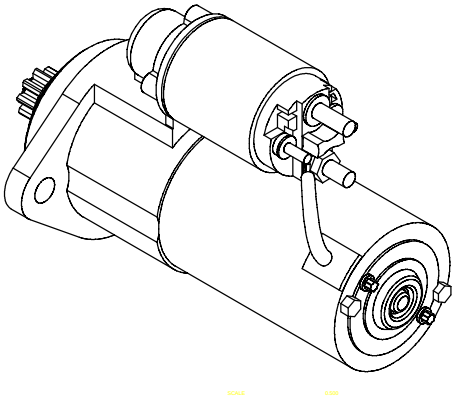
Delco PG260G1



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Delco PG260L

Description

The Permanent Magnet Gear Reduction starter motors feature small permanent magnets mounted inside the field frame (NOTE: The actual configuration of these magnets differs between the PG200, PG250 and PG260; the field frames with permanent magnets are not interchangeable. Otherwise, the units are similar.) These magnets take the place of current-carrying field coils mounted on iron pole pieces. Internal gear reduction, approximately 4:1 ratio, through planetary gears results in armature speeds in the 7000 rpm range. The armature and drive shaft are mounted on roller or ball bearings in place of bushings. The solenoid switch, plunger, return spring, and shift lever are permanently mounted in the drive housing.

Replacement Parts Warning

⚠ WARNING

Electrical, ignition, and fuel system components on Mercury MerCruiser Engines and Sterndrives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition, or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition, and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Specifications

PG260G1

Mercury Part Number			50-863007A1			
Delco Identification Number	Engine Rotation	Volts	No Load Test			
			Minimum amp	Maximum amp	Minimum rpm	Maximum rpm
9000884	LH	12.0	35	85	2550	4150

PG260L

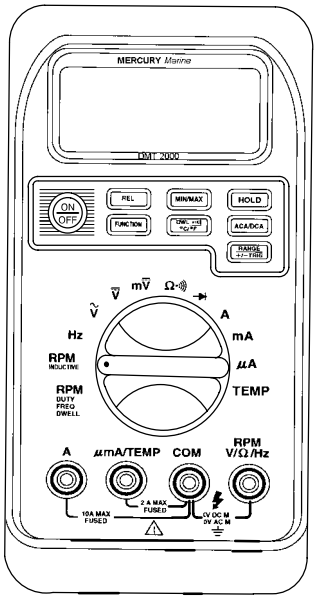
Mercury Part Number			50-808011A4			
Delco Identification Number	Engine Rotation	Volts	No Load Test			
			Minimum amp	Maximum amp	Minimum rpm	Maximum rpm
9000888	LH	12.0	35	85	2550	4150

Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Liquid Neoprene	Terminals on the starter solenoid	92-25711-3

Equivalent products may be used.

Special Tools

DMT 2000A Tachometer / Multi-Meter Kit		
 77959	Measures rpm on both 2 and 4 cycle marine engines, records the maximums and minimums simultaneously and will read accurately in high RFI environments. Replacement components: 91-854010-1 Inductive Pick-Up 8 ft (2.4 m) 91-854011-1 Temperature Probe 91-854012 Ferrite Core 91-854013-1 Interface Module 91-854014-1 Hard Carrying Case 91-854015-1 User’s Guide 91-802651 Test Leads Optional Accessories: 84-854016T 8 ft. (2.4 m) Inductive Pick-Up Extension 91-802650-1 Clamp-On Current Probe 91-89045-1 Direct Voltage Adapter	91-854009A3

Precautions

⚠ CAUTION

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

Torque Specifications

PG260F1

NOTE: *Securely tighten all fasteners not listed below.*

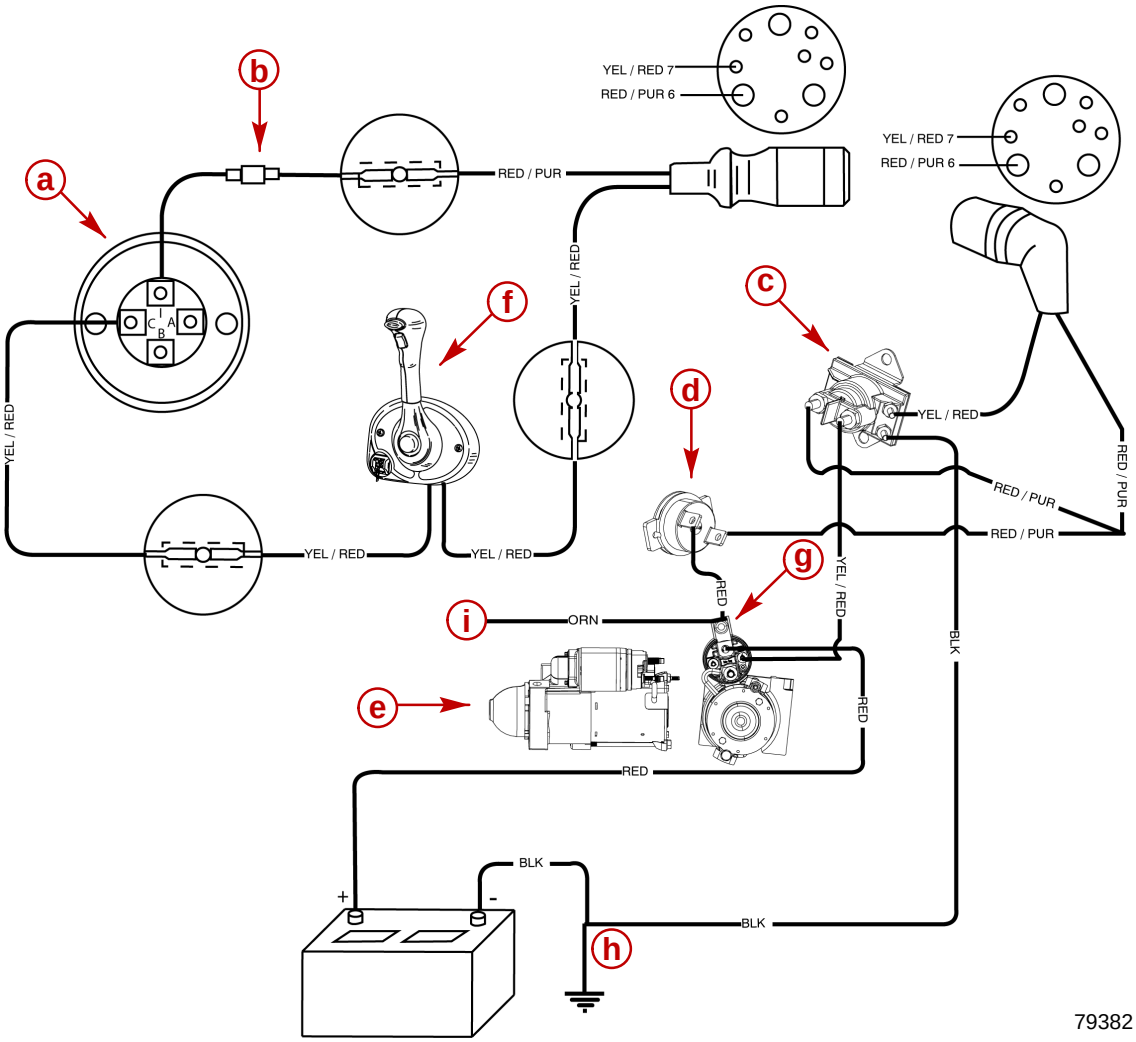
Description	Nm	lb-in.	lb-ft
Starter mounting bolts	40.6		30
Battery terminal nut	9	84	
Switch terminal nut	2	20	
Resistor terminal nut	2	20	

PG260L

NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb-in.	lb-ft
Starter mounting bolts	40.6		30
Battery terminal nut	9	84	
Switch terminal nut	2	20	
Resistor terminal nut	2	20	

Starting System Diagram



a - Ignition switch
b - 20 amp fuse
c - Starter slave solenoid
d - Circuit breaker
e - Starter motor
f - Neutral safety switch
g - 90 amp fuse
h - Engine ground (–)
i - To the alternator

Positive Current Flow

This is a general description of the positive current flow from the battery through the system until the starter motor cranks.

NOTE: *Ensure that all connections are tight and have the required resistance.*

- Battery to the solenoid switch (on starter) (RED battery cable)
- Solenoid switch to the circuit breaker (RED)
- Circuit breaker to the wire junction (RED/PUR)
- Wire junction to the wiring harness plug (RED/PUR) terminal 6
- Wiring harness plug to the 20 amp fuse (RED/PUR)
- 20 amp fuse to the ignition switch terminal I (RED/PUR); ignition switch is in the “START” position
- Ignition switch terminal I to terminal C
- Ignition switch terminal C to the neutral start switch (YEL/RED); NEUTRAL START SWITCH MUST BE AT NEUTRAL POSITION
- Neutral start switch to the wiring harness plug terminal 7 (YEL/RED)
- Wiring harness plug to the starter solenoid (small terminal) (YEL/RED); also, ensure that the black (small terminal) wire is grounded
- Starter solenoid is now closed, completing the circuit between the large terminal (RED/PUR) and the other large terminal (YEL/RED), causing the starter motor to crank.

Battery Cable Recommendations

NOTE: *Battery should be located as close to engine as possible.*

1. Select proper size positive (+) and negative (–) battery cables using the chart.
   a. Add the positive and negative cable lengths together.
   b. Divide by 2 to obtain the average cable length.

IMPORTANT: Terminals must be soldered to cable ends to ensure good electrical contact. Use electrical grade (resin flux) solder only. Do not use acid flux solder, as it may cause corrosion and a subsequent failure.

Average Cable Length	Cable Gauge
Up to 1.1 m (3-1/2 ft)	25 mm^2 (4)
1.1-1.8 m (3-1/2 - 6 ft)	35 mm^2 (2)
1.8-2.3 m (6 - 7-1/2 ft)	50 mm^2 (1)
2.3-2.9 m (7-1/2 - 9-1/2 ft)	50 mm^2 (0)
2.9-3.7 m (9-1/2 - 12 ft)	70 mm^2 (00)
3.7-4.6 m (12 - 15 ft)	95 mm^2 (000)
4.6-5.8 m (15 - 19 ft)	120 mm^2 (0000)

Testing

Voltage Drop Test

Other than water damage, low voltage causes most starter motor failures. Low voltage causes excessive heat to build up in the starter motor. It can also cause starter motor solenoid contact problems.

IMPORTANT: Perform these tests with a digital voltmeter before removing the starter from the engine.

1. Set the digital voltmeter to 0 before testing.
2. Ensure that the battery is fully charged.
3. Remove the coil wire from the distributor cap and ground it to prevent the engine from starting.
4. Connect the voltmeter positive (+) lead directly to the large, threaded terminal.
5. Connect the voltmeter negative (–) lead directly to an unpainted metal surface on the starter housing.
6. Crank the engine over with the key switch for 10-15 seconds while observing the voltmeter.

- A voltmeter reading of 9.5 volts or more indicates that the battery is supplying sufficient voltage to the starter to operate properly. If the starter does not function properly, the starter or the engine are malfunctioning. Remove the spark plugs and try turning the engine over by hand to rule out an engine problem.
- A voltmeter reading below 9.5 volts indicates a voltage loss between the starter motor and the battery. Example: Voltage measured at the battery posts indicates 12.5 volts. Voltage measured at the starter indicates 9 volts. There is a 3.5 volt drop between the battery posts and the starter. Corroded battery cables, loose or dirty connections, loose battery cable terminal crimps, under size battery cable gauge for length used in boat, painted surfaces, or battery switches could be the cause of this voltage drop.

IMPORTANT: The maximum voltage drop allowed is 0.5 volts.

Low Voltage Test

1. Test the battery positive (+) cable first. Connect voltmeter positive (+) lead directly to the battery positive (+) post, not the battery cable ring terminal. Connect voltmeter negative (–) lead directly to the large, threaded starter motor terminal to which the battery positive (+) cable is connected.

NOTE: *Remove one voltmeter lead before starter motor is turned off or voltmeter damage may occur. The starter may produce a voltage spike that can damage a voltmeter.*

2. Crank the engine over while observing the voltmeter. The maximum allowed drop is 0.25 volts.

3. To find the point where the resistance is highest, leave the voltmeter positive (+) lead on the battery post and move the voltmeter negative (–) lead to the battery positive (+) cable ring terminal, which is on the threaded starter terminal.
4. Move voltmeter negative (–) lead to the battery cable itself, which is inside the crimped battery cable ring terminal.
5. Continue to test each battery cable connection back to the battery positive (+) post. If a battery switch is used, check between the battery cable ring terminal and the switch's terminal.
6. Check for voltage drop on the battery negative (–) cable. Connect voltmeter negative (–) lead directly to the battery negative (–) post, not the battery cable ring terminal. Connect voltmeter positive (+) lead to an unpainted surface of the starter housing.

NOTE: *Remove one voltmeter lead before starter motor is turned off or voltmeter damage may occur. The starter may produce a voltage spike that can damage a voltmeter.*

7. Crank engine over while observing the voltmeter.

IMPORTANT: The maximum allowed drop is 0.25 volts.

8. To find the point where the resistance is highest, leave voltmeter negative (–) lead on battery negative (–) post and move voltmeter positive (+) lead to the ground stud where the battery negative (–) cable is connected.
9. Move the voltmeter negative (–) lead to the battery negative (–) cable ring terminal that is on the ground stud.
10. Move the voltmeter positive (+) lead to the battery cable itself, which is inside the crimped battery cable ring terminal.
11. Test each battery cable connection in this manner back to the battery post.
12. After testing to ensure that the starter motor is getting at least 9.5 volts, test the starter motor solenoid for at least 9.5 volts from the slave solenoid during cranking. Low voltage at the starter solenoid can cause intermittent operation of the solenoid contacts and shorten the life of the solenoid.
13. Connect the voltmeter positive (+) lead to the terminal on the starter solenoid with the YEL/RED wire from the slave solenoid connected to it.
14. Connect the voltmeter negative (–) lead to unpainted surface of the starter housing.
15. Crank engine over and observe the voltmeter. If the starter solenoid is not getting 9.5 volts, the YEL/RED wire or the slave solenoid could be the cause of the low voltage.

Water or Corrosion Inspection

1. Remove the 2 short screws from the end cap and inspect the threads.

- If they are clean and gold in color, the starter motor did not have water inside of it.
- If they are dirty and black or gray in color, the starter motor may have had water on the inside of it and it should be replaced.

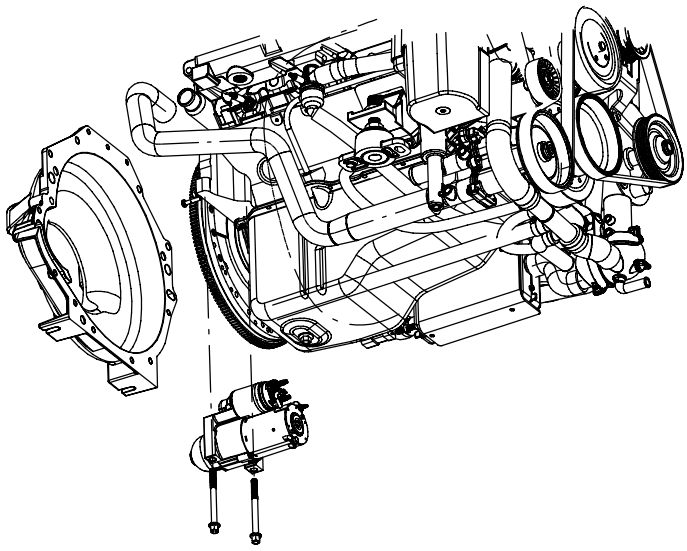
IMPORTANT: Starter damage caused by water will not be covered by the Mercury MerCruiser warranty.

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire, or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect the battery cables from the battery.
2. Disconnect the wires from the solenoid terminals.
3. Remove the starter mounting bolts.
4. Pull the starter assembly away from the flywheel and remove from the engine.



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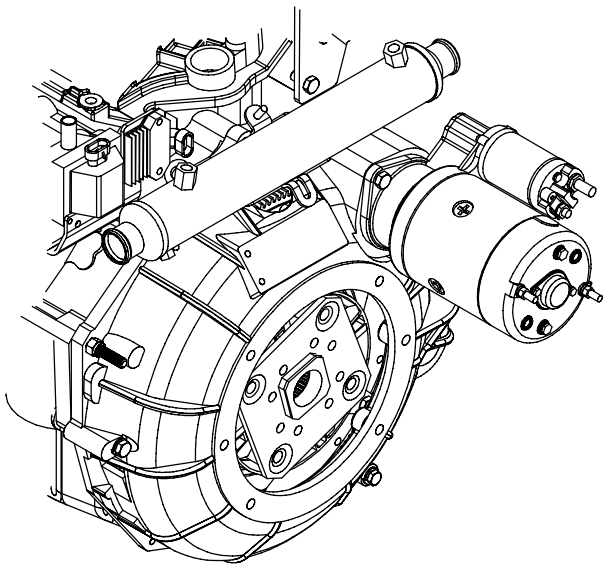
PG260G1



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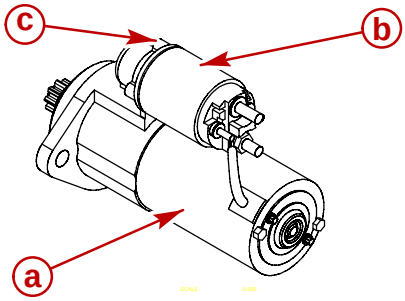
PG260L

Solenoid Switch

1. Remove the 3 fasteners retaining the solenoid. Remove the solenoid from the drive housing.



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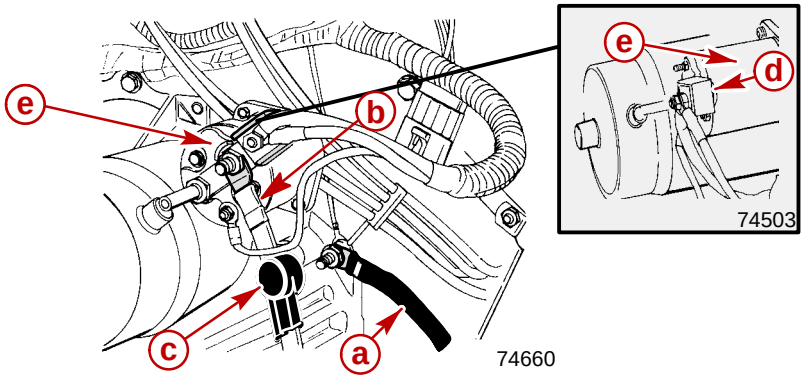
Delco PG260L

a - Drive housing
b - Solenoid
c - Fasteners (3)

Inspection

The cranking motor and the solenoid are completely enclosed in the drive housing to prevent the entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect the terminals for corrosion and loose connections.



74660
74503

a - Negative (BLK) battery cable
b - Positive (RED) battery cable
c - Rubber boot (shipped with engine)
d - 90 Amp fuse - do not remove
e - Starter Solenoid

Description	Where used	Part number
Liquid Neoprene	Battery cable terminals	92-25711-3

2. Inspect the wiring for frayed and worn insulation.
3. Ensure that the starter mounting bolts are tight.

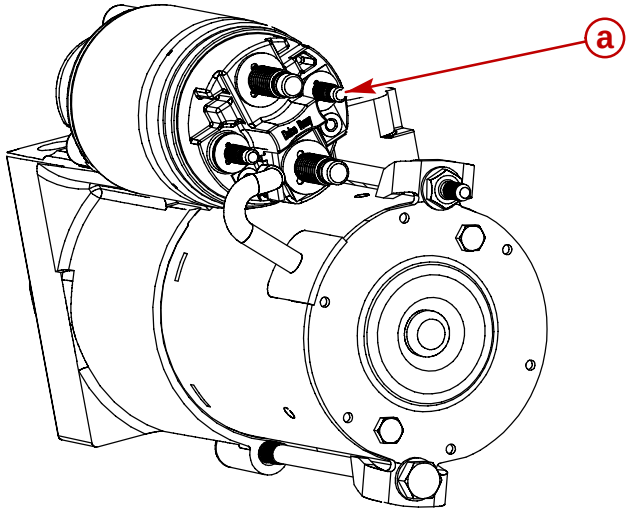
Installation

IMPORTANT: Install the special mounting shim (if equipped) between the starter motor and the engine block.

1. Place the starter motor in position and install the mounting bolts. Torque the bolts.

Description	Nm	lb-in.	lb-ft
Starter mounting bolts	40.6		30

2. Connect the YELLOW/RED wire to the switch “S” terminal. Torque terminal nut.



79333

Typical

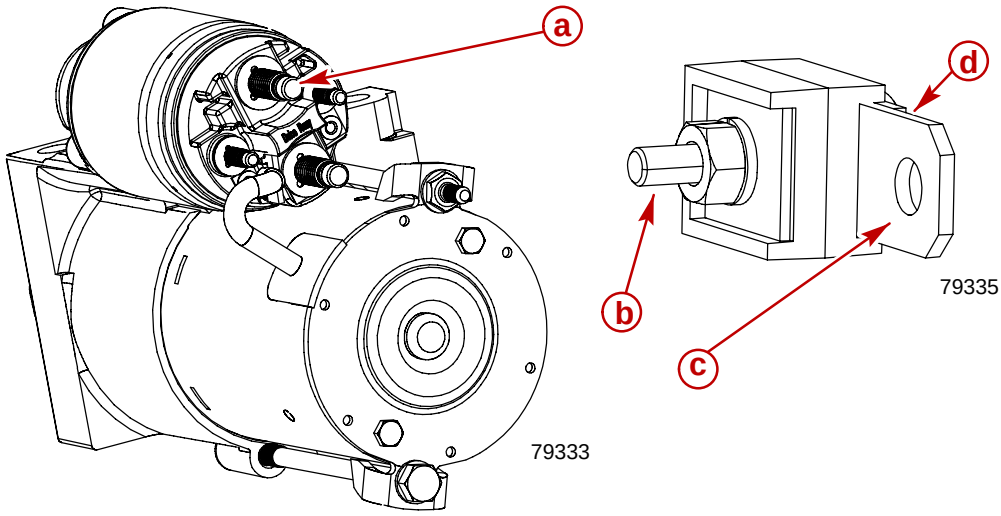
a - Switch terminal, “S”

Description	Nm	lb-in.	lb-ft
Switch terminal nut	2	20	

3. Connect the positive (+) battery cable and the 90 amp fuse to the battery terminal. Torque terminal nuts.

Description	Nm	lb-in.	lb-ft
Battery terminal nut, PG 260 series	9.5	84	

4. Connect the ORANGE wire and the RED wire to the post on the 90 amp fuse. Tighten terminal nut securely.



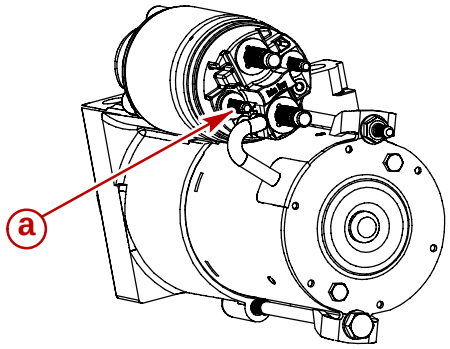
Typical

a - Battery terminal, “B+”
b - 90 amp fuse post
c - Connection to battery terminal
d - Phenolic insulator

NOTE: *The back side of the fuse is an insulator.*

NOTE: *The PURPLE/YELLOW wire is the 12 volt battery positive (+) to the electronic fuel pump while the engine is in starting mode.*

5. **Carbureted Models:** Connect the PURPLE/YELLOW wire to the resistor “R” terminal. Torque terminal nut.



79333

Typical

a - Resistor terminal, “R”

Description	Nm	lb-in.	lb-ft
Resistor terminal nut	2	20	

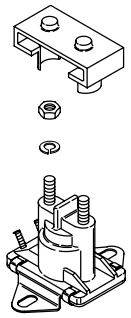
6. Coat the terminals with sealant.

Description	Where Used	Part Number
Liquid Neoprene	Terminals on the starter solenoid	92-25711-3

7. Install the battery cable boot, if equipped.
8. Connect the positive (+) battery cable to the positive (+) battery terminal and tighten the cable clamp.
9. Connect the negative (–) battery cable to the negative (–) battery terminal and tighten the clamp.

Standard Starter Slave Solenoid

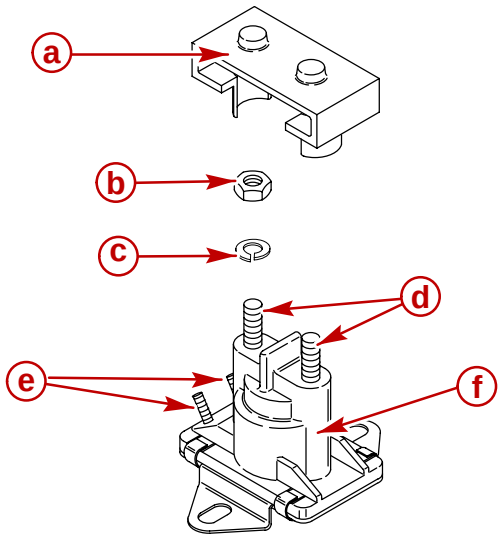
Identification



76517

Removal

1. Remove and retain the starter solenoid insulator.
2. Remove and retain the starter solenoid top terminal nuts and lockwashers.
3. Mark the position of the engine harness wires on the starter solenoid top terminals, and remove the wires from the starter solenoid.
4. Mark the position of the engine harness boot connectors on the starter solenoid side terminals. Remove the connectors from the starter solenoid.
5. Remove and retain the solenoid retaining screws.
6. Remove the starter solenoid.

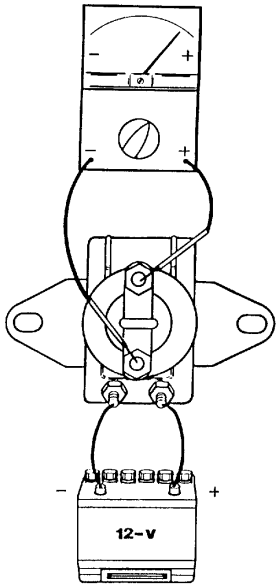


76517

a - Insulator
b - Top terminal nut
c - Top terminal lockwasher
d - Top terminal
e - Side terminal
f - Starter solenoid

Testing

1. Using continuity meter, connect test leads as shown; then, connect 12 volt battery with jumper leads as shown.



72630

2. If no meter movement is present, replace solenoid.

Installation

1. Place starter solenoid on the mounting bracket and secure with the starter solenoid retaining screws.
2. Connect the engine harness boot connectors to the starter solenoid side terminals.
3. Connect the engine harness wires to the starter solenoid top terminals, with the lockwashers and nuts. Tighten securely.
4. Install the starter solenoid insulator onto the starter solenoid top terminals.

NOTES:

ELECTRICAL SYSTEMS

Section 4B - Carbureted Ignition System

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4 B

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on Mercury MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Specifications

Distributor

Description	Specifications
Distributor (Part Number)	805185A36

Coil

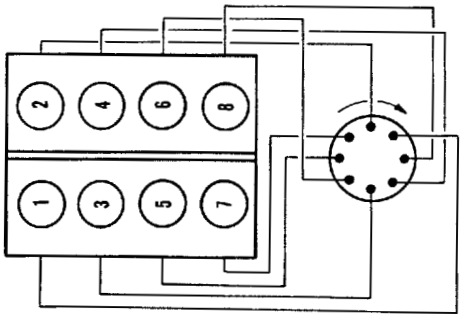
Description	Specification
Coil (Part Number)	392-805570A2
Primary resistance	0.60-0.80 ohms
Secondary resistance	9,400-11,700 ohms

Spark Plugs

Description	Specification
Spark plug type	AC-MR43LTS NGK BPR6FS Champion RS12YC
Spark plug gap	1.14 mm (0.045 in.)

Specifications (continued)

Firing Order



72008

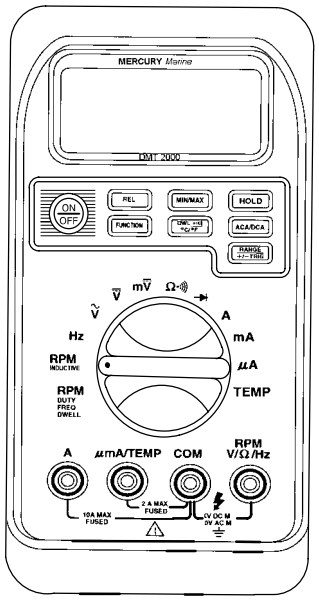
Description	Specification
Firing order	1-8-4-3-6-5-7-2
Ignition timing	10° BTDC

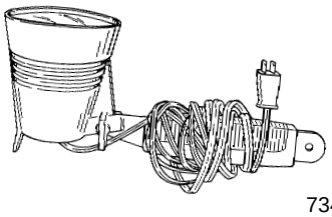
Lubricants / Sealants / Adhesives

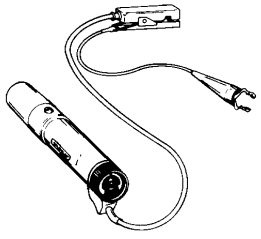
Description	Where Used	Part Number
Liquid Neoprene	Electronic terminals	92-27511-3
Loctite 271 Threadlocker	Rotor locating key	92-809819
	Distributor shaft keyway	
Tite Seal Compound	Coil high tension lead tower	92-41669--1
Engine Oil	Distributor shaft	Obtain locally

Equivalent products may be used.

Special Tools

DMT 2000A Tachometer / Multi-Meter Kit		
 77959	Measures rpm on both 2 and 4 cycle marine engines, records the maximums and minimums simultaneously and will read accurately in high RFI environments. Replacement components: 91-854010-1 Inductive Pick-Up 8 ft (2.4 m) 91-854011-1 Temperature Probe 91-854012 Ferrite Core 91-854013-1 Interface Module 91-854014-1 Hard Carrying Case 91-854015-1 User's Guide 91-802651 Test Leads Optional Accessories: 84-854016T 8 ft. (2.4 m) Inductive Pick-Up Extension 91-802650-1 Clamp-On Current Probe 91-89045-1 Direct Voltage Adapter	91-854009A3

Torch Lamp		
 73437	120v Torch Lamp, used for heating components to ease installation and removal. 120v Replacement bulb 91-63210 ***NOTE:*** *240v Torch Lamp 91-74042 is no longer available. Replacement 240v bulb 88-68664 is available.*	91-63209

Portable Timing Light		
 73664	Checks the ignition timing, powered by 2 D-cell batteries.	91-99379

Precautions

⚠ CAUTION

Avoid personal injury and/or property damage. Listed below are some of the precautions, along with others listed throughout this manual, that you should observe to help ensure an accident-free maintenance experience:

- **Always disconnect battery cables from battery BEFORE working on electrical system to prevent injury to yourself or damage to electrical system.**
- **Ensure that engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of fire.**
- **Keep hands, feet, and clothing clear of moving parts.**
- **Do not touch or disconnect any ignition system parts while engine is running.**
- **Do not reverse battery cable connections. System is negative (–) ground.**
- **Do not disconnect battery cables while engine is running.**
- **When working on engine, spark plug holes and carburetor throat should be kept covered to prevent foreign objects from entering combustion chamber.**
- **Replace a component if there is any doubt as to the condition of the component.**

Torque Specifications

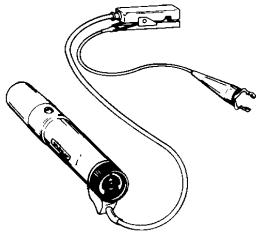
NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb-in.	lb-ft
Spark plugs (new cylinder head)	29.8		22
Spark plugs (used cylinder head)	14	132	
Knock sensor	18.9		14
Distributor clamping screw	24.4		18

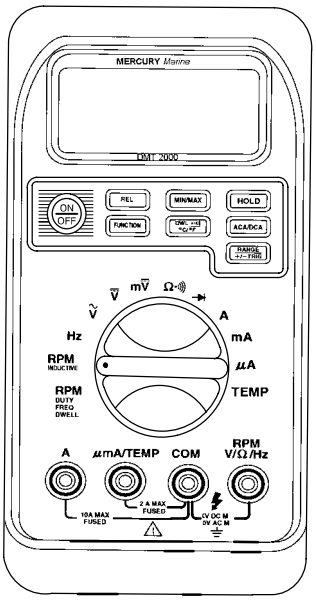
Ignition Timing

Thunderbolt V Models

1. Connect timing light to number 1 spark plug wire.

Portable Timing Light		
 73664	Checks the ignition timing, powered by 2 D-cell batteries.	91-99379

2. Connect a shop tachometer to the engine.

DMT 2000A Tachometer / Multi-Meter Kit		
 77959	Measures rpm on both 2 and 4 cycle marine engines, records the maximums and minimums simultaneously and will read accurately in high RFI environments. Replacement components: 91-854010-1 Inductive Pick-Up 8 ft (2.4 m) 91-854011-1 Temperature Probe 91-854012 Ferrite Core 91-854013-1 Interface Module 91-854014-1 Hard Carrying Case 91-854015-1 User's Guide 91-802651 Test Leads Optional Accessories: 84-854016T 8 ft. (2.4 m) Inductive Pick-Up Extension 91-802650-1 Clamp-On Current Probe 91-89045-1 Direct Voltage Adapter	91-854009A3

IMPORTANT: Before starting the engine, connect a jumper wire from the ignition timing lead to a good ground. This has to be done before the ignition key is turned to the "ON" position to lock the ignition module into Base Timing Mode.

3. Before starting the engine, connect jumper wire from timing lead to a good ground.

NOTE: *The PUR/WHT timing lead is located towards the front of the engine near the fuel line or near the distributor, as equipped for your model.*

4. Start engine and operate at 1300 rpm until it reaches normal operating temperature.
5. Disconnect throttle cable from the carburetor.
6. With engine at idle rpm, adjust the carburetor idle rpm screw to the specified engine idle rpm.
7. With the engine still at idle rpm, check the ignition timing. If incorrect, rotate the distributor until timing is correct.

Description	Nm	lb-in.	lb-ft
Distributor clamping screw	24.4		18

IMPORTANT: Idle mixture screw can only be adjusted on models produced prior to JANUARY 1, 2003

8. Adjust the idle mixture screw; inward is LEAN, outward is RICH.
9. Recheck ignition timing.
10. Stop engine. Remove timing light, jumper wire and shop tachometer.

IMPORTANT: Timing jumper wire has to be removed or the ignition module will stay locked in the Base Timing Mode and it will not be able to advance the ignition timing correctly when the engine rpm is increased.

11. Adjust and reinstall throttle cable. Open and close remote control throttle lever to ensure that the carburetor's throttle lever returns against the rpm adjusting screw every time.
12. Restart the engine, increase rpm to 1300; then, return to idle position slowly and shut the engine off. Ensure that the carburetor throttle lever returns against the idle rpm screw.
13. Shut engine off.

Spark Plugs

Removal

1. Disconnect the spark plug wires (high tension leads) from the spark plugs.

NOTE: *Use care when removing the spark plug wires and boots from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the* ***boot*** *to remove the wire.*

2. Remove the spark plugs.

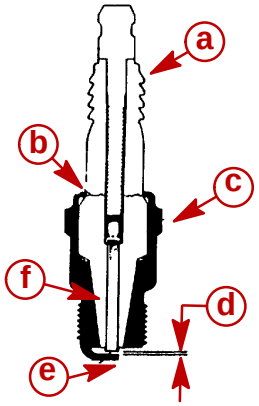
NOTE: *A thin-walled spark plug socket may be required.*

Inspection

1. Inspect each spark plug for the manufacturer and spark plug number. All plugs must be from the same manufacturer and have the same spark plug number.

Description	Specification
Spark plug type	AC-MR43LTS NGK BPR6FS Champion RS12YC

2. Inspect each plug individually for worn electrodes and for glazed, broken, or blistered porcelain. Check the joint between the insulator and the shell for cracks. Replace as necessary.

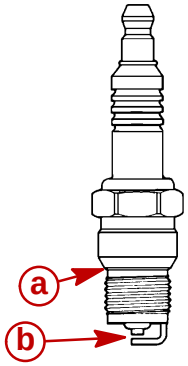


72734

a - Porcelain insulator
b - Insulator
c - Shell
d - Proper gap
e - Side electrode
f - Center electrode (when adjusting gap - do not bend)

Installation

1. Clean the spark plug seating area on the cylinder heads.
2. Adjust the spark plug gap with a round feeler gauge. Bend the side electrode to adjust the gap. Do not bend the center electrode.



75084

a - Seating area
b - Gap

Description	Specification
Spark plug gap	0.045 in.

IMPORTANT: Spark plugs should be torqued to the amount specified. In the absence of a torque wrench or access problems to the plugs, the spark plugs should be hand tightened until the plug seats on the cylinder head and then securely tightened with the appropriate ratchet and socket.

3. Install the spark plugs and torque.

Description	Nm	lb-in.	lb-ft
Spark plugs (new cylinder head)	29.8		22
Spark plugs (used cylinder head)	14	132	

4. Install the spark plug wires in the proper order.

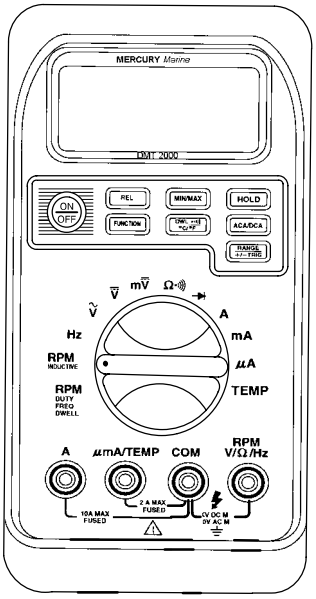
Spark Plug Wires

Inspection

1. Visually inspect the spark plug wires and the coil wire for damage.
2. Visually inspect the spark plug boots for damage.

NOTE: *Use care when removing the spark plug wires and the boots from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the* ***boot*** *to remove the wire end.*

3. Check the spark plug wires and the coil wire for continuity using a multi-meter.

DMT 2000A Tachometer / Multi-Meter Kit		
 77959	Measures rpm on both 2 and 4 cycle marine engines, records the maximums and minimums simultaneously and will read accurately in high RFI environments. Replacement components: 91-854010-1 Inductive Pick-Up 8 ft (2.4 m) 91-854011-1 Temperature Probe 91-854012 Ferrite Core 91-854013-1 Interface Module 91-854014-1 Hard Carrying Case 91-854015-1 User's Guide 91-802651 Test Leads Optional Accessories: 84-854016T 8 ft. (2.4 m) Inductive Pick-Up Extension 91-802650-1 Clamp-On Current Probe 91-89045-1 Direct Voltage Adapter	91-854009A3

4. Replace any damaged wires.

Installation

IMPORTANT: Use only the spark plug wires recommended for marine applications.

NOTE: *When replacing the spark plug wires, replace one wire at a time to reduce the risk of error.*

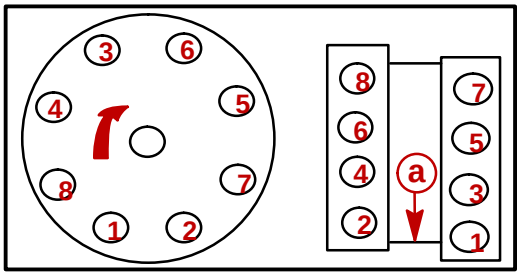
1. Disconnect the individual spark plug wires.
2. Install the spark plug wires in the proper order. Observe the following:

IMPORTANT: When replacing the plug wires, route the wires correctly through the proper supports. Correct positioning of the spark plug wires and supports is important to prevent cross-firing.

IMPORTANT: When routing plug wires, route to avoid contact with all other electronic components.

a. Position the wires in the spark plug wire supports and retainers.

b. Attach the plug wires to the appropriate spark plug and terminal on the distributor cap. Each end should fit securely.



Rotor rotation on LH engine

a - Front

IMPORTANT: Before installing the coil wire (high tension lead) to the coil, apply Tight Seal Compound around the top of the coil high tension lead tower. Do not apply to the inside of the tower hole.

c. Apply sealant. Attach coil wire (high tension lead) to center terminal on distributor cap.

Description	Where Used	Part Number
Tite Seal Compound	Coil high tension lead tower	92-41669--1

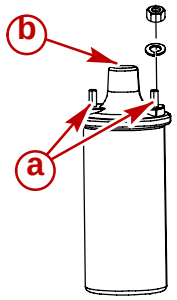
d. Push the end of the high tension wire into the coil tower. Position the boot over the coil tower and wipe off excess insulating compound.

NOTE: *Ensure that the boot does not come off of the tower due to hydraulic air pressure inside the boot.*

Ignition Coil

Removal

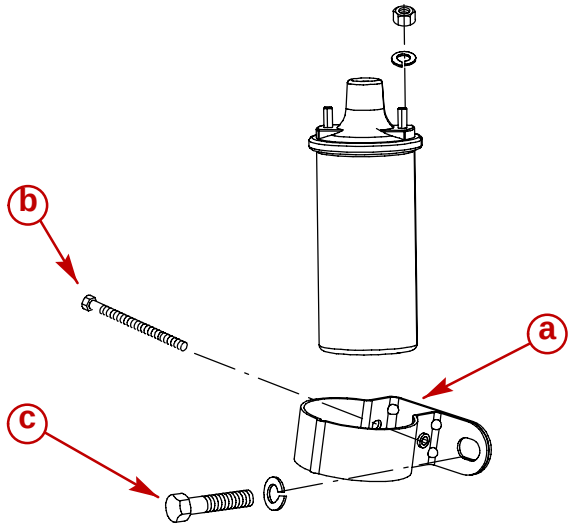
1. Disconnect wire harness connectors at ignition coil.



79337

a - Wire harness connection
b - High tension coil lead connection

2. Remove high tension coil lead.
3. Remove coil bracket fasteners and remove coil bracket with ignition coil.



79337

a - Coil bracket
b - Coil bracket tensioning pin
c - Coil bracket screw and washer

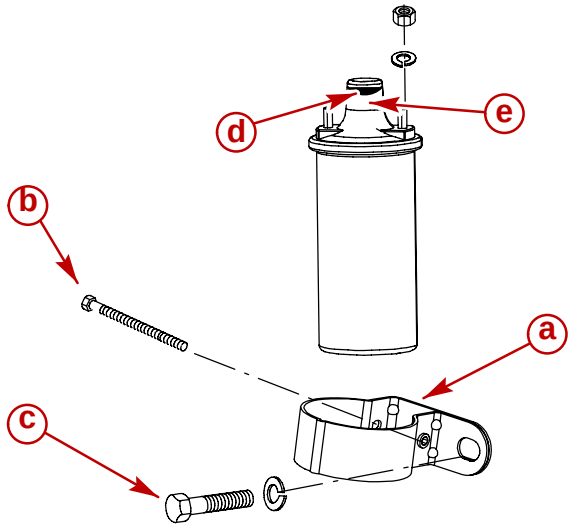
4. Remove the coil bracket fasteners and remove the coil bracket assembly from the engine.

Installation

1. Install the ignition coil and bracket to the engine bracket with fasteners.

IMPORTANT: Before installing the coil wire (high tension lead) to the coil, apply Tight Seal Compound around the top of the coil high tension lead tower. Do not apply to the inside of the tower hole.

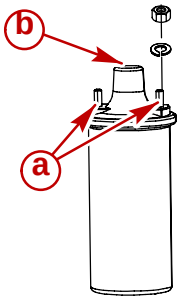
2. Apply a thin bead of Tight Seal Compound around the outside rim of the coil high tension lead tower. Ensure that Tight Seal Compound is not applied inside the coil high tension lead tower.



79337

a - Coil bracket
b - Coil bracket tensioning pin
c - Coil bracket screw and washer
d - Tite Seal Compound
e - High tension coil lead tower

3. Connect high tension coil lead.
4. Connect wire harness connectors.



79337

a - Wire harness connection
b - High tension coil lead connection

Description	Where Used	Part Number
Tite Seal Compound	Coil high tension lead tower	92-41669--1

Thunderbolt V Ignition

Spark Control Features

IDLE SPEED SPARK CONTROL

The ignition module controls ignition timing to maintain a calibrated idle speed by making small spark advance adjustments. This feature is only active between 400-700 rpm.

ACCELERATION SPARK ADVANCE

When accelerating, the ignition module may add more spark advance to the Base Spark Timing Curve. The amount of spark advance added depends on how fast rpm increases. This feature is also active between 1200-4000 rpm. Within this range, the module can add approximately 10 degrees of spark advance to the base spark timing curve.

MEAN-BEST-TIMING (MBT) SPARK ADVANCE

During light load cruising, the ignition module maintains optimal ignition timing by making small spark advance adjustments. At a given rpm, the module will add a small amount of advance and wait to see if there is an rpm change. If rpm increases, it will increase timing more. The module will continue to advance timing until it no longer gets an increase in rpm. Conversely, if it senses an rpm drop, it will start to retard some of the spark timing. Between 1200-4000 rpm the ignition module can add approximately 10-15 degrees of spark advance to the base spark timing curve.

NOTE: *The Audio Warning System is also connected into the ignition module circuit. If the audio warning system becomes activated by the closing of one of the audio warning system switches, the MBT feature is deactivated.*

OVER-SPEED CONTROL

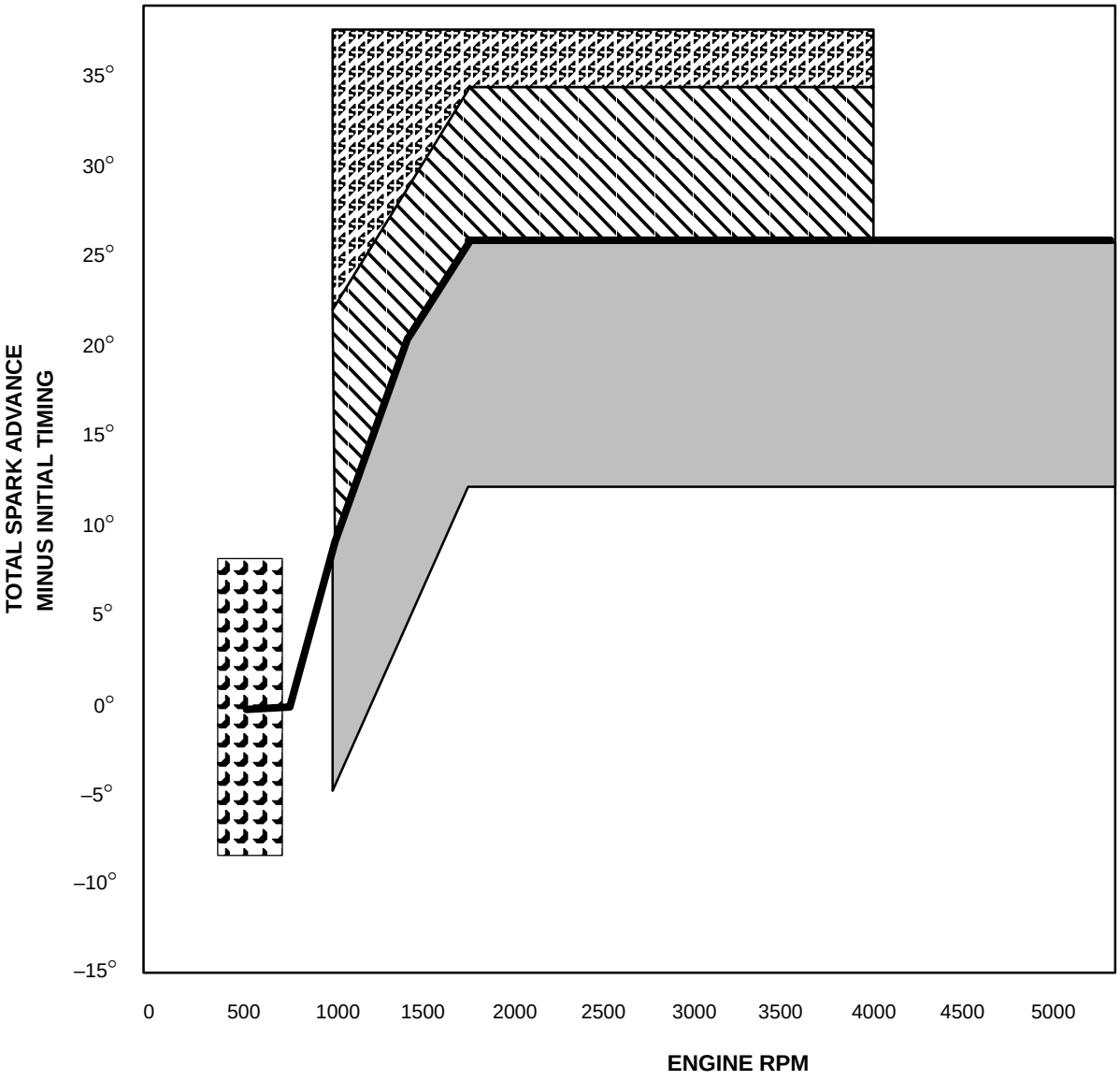
The ignition module will prevent the engine speed from exceeding a preset limit by stopping the spark. The over-speed limit is set slightly higher than the top end of the rpm range. For example, if the recommended range is 4600-5000 rpm, the over-speed limit would be set at 5100 rpm. When rpm reaches this limit, spark is turned-off until engine rpm drops down to a RESET rpm, which would be approximately 4750 rpm for this example. At this point, spark comes back on.

KNOCK RETARD SPARK CONTROL

The knock control feature helps provide protection from harmful detonation. Knock control is handled by the knock control module. This module receives a signal from a sensor that is mounted on the engine block. The knock control module works in conjunction with the ignition module to retard the timing if spark knock is present.

Thunderbolt V Spark Control Graph

IMPORTANT: The graph shows the typical advance ranges for a Thunderbolt V ignition control module. The numbers plotted on the graph are not representative of any particular model. It is only presented to provide an understanding of how the system functions.



= Base Timing Advance Curve

= Idle Speed Advance Range

= Knock Retard Range

= Acceleration Advance Range

= MBT Advance Range (Not A Function On Tow Sports Models)

Circuit Description

Refer to the Ignition System Wiring Diagram for reference to these circuit descriptions.

IGNITION CONTROL MODULE

- The ignition module receives power (+) through the PUR wire.
- Ignition module ground (–) is accomplished through the BLK wire.
- There is also a case ground (–) wire that is connected to one of the ignition module attaching screws.
- The 12 volt signal from the ignition module to the distributor is carried through the WHT/RED wire to the distributor sensor and back to the ignition module through the WHT/GRN wire.
- The tachometer signal is carried to the instrument panel through the GRY wire.
- The PUR/WHT wire carries the signal from the knock control module to the ignition control module.
- There are 2 BLK wires that have bullet connectors. This circuit is reserved for future options. On current models, the 2 BLK wires must be connected for the system to function properly.
- The TAN/BLU wire carries a signal from the Audio Warning Circuit to the ignition module.

KNOCK CONTROL MODULE

- The knock control module receives power (+) from the PUR wire.
- Knock module ground (–) is accomplished through the BLK wire.
- The PUR/WHT wire carries the signal from the knock control module to the ignition control module.
- The BLU wire carries the signal from the knock sensor to the knock module.

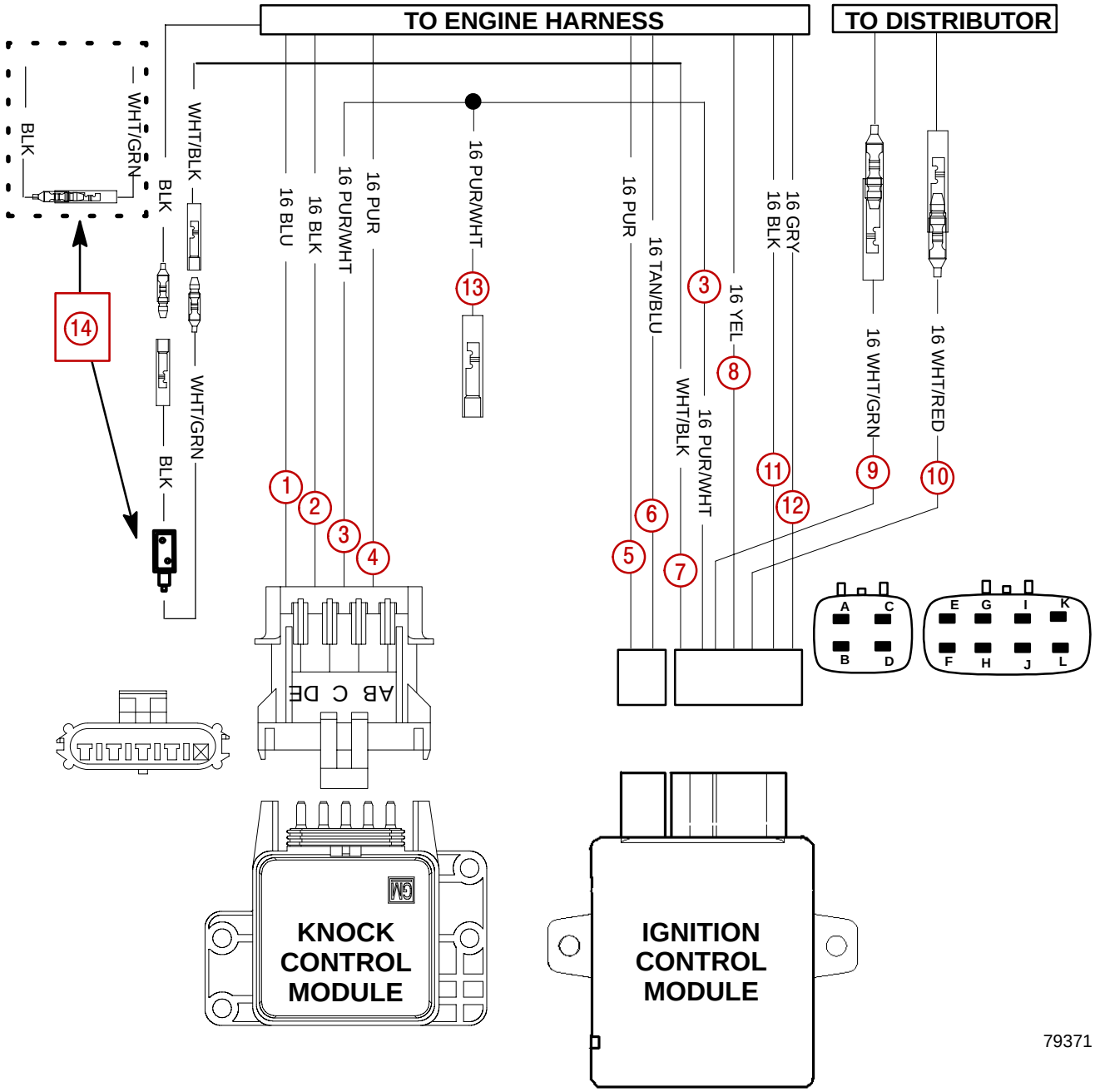
IGNITION CONTROL SYSTEM TIMING LEAD

The ignition control system has a lead with bullet connector that is connected into the PUR/WHT wire. This lead is used for performing the following tests and procedures:

- Setting Base Ignition Timing
- Setting Engine Idle Speed
- Setting Idle Mixture
- Testing Knock Control Circuit

This lead, when connected to an engine ground (–), locks the ignition control module into the Base Timing Mode.

Ignition System Wiring Diagram



1 - Knock sensor wire
2 - Ground wire (–) for knock module
3 - Knock module signal wire
4 - Battery (+) positive wire to knock module
5 - Battery (+) positive wire to ignition module (pin C)
6 - Audio warning system wire (pin D)
7 - Shift system interrupt switch, if equipped (pin E)
8 - Water temperature switch - for audio warning (pin H)
9 - Distributor wire (pin G)
10 - Distributor wire (pin I)
11 - Ignition module grd (–) wire (pin J)
12 - Tachometer wire (pin L)
13 - Timing lead - for setting timing and other tests
14 - See note

NOTE: *Alpha models are equipped with a shift cut-out switch. 305, 350 and 377 cid Bravo models will have 2 BLACK leads connected together.*

Thunderbolt V Ignition Module

REMOVAL

1. Unplug wiring harness connectors from ignition module.
2. Remove fasteners and hardware retaining ignition module to exhaust elbow.
3. Remove module.

CLEANING AND INSPECTION

1. Ensure that terminals of wiring harness connector are clean and free of corrosion.

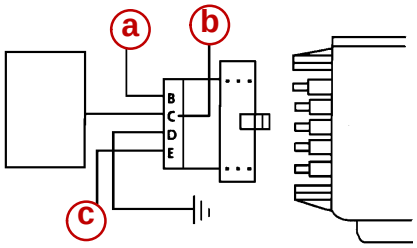
INSTALLATION

1. Install ignition module using existing hardware. Tighten securely.
2. Plug connectors into ignition module.

Knock Control Module

DESCRIPTION

The knock control module monitors the knock sensor's AC voltage signal and supplies an 8-10 volt signal, if no spark knock is present, to the ignition control module. If spark knock is present, the knock control module will remove the 8-10 volt signal to the ignition control module.



Knock sensor System

a - Positive lead (12 volts)
b - 8-10 volts to knock sensor
c - Knock sensor

IMPORTANT: The correct knock module and sensor must be used. Using an incorrect knock module or sensor will result in unrecognized spark knock and engine damage.

The knock module terminal "B" is powered by 12 volts from the ignition switch. If the 12 volt power source is not present, the knock module cannot send an 8-10 volt signal to the ignition control module and a false constant spark retard will result.

Terminal "E" of the knock module is the signal line from the knock sensor. If this circuit opens or shorts to ground, the knock module will never remove the 8-10 volt signal from terminal "C" and no spark retard will occur.

The ground circuit for the knock module is connected to terminal "D." If the ground circuit opens, the knock module will not be able to remove the 8-10 volt signal and spark knock cannot be controlled.

IMPORTANT: If knock sensor wire is routed too close to secondary ignition wires, the knock module may see the interference as a knock signal, resulting in false timing retard.

IMPORTANT: If there is abnormal mechanical engine noise (rattles or knocks), they may give a false knock retard signal. If fuel octane is too high or too low, a false signal can also be sent.

TESTING KNOCK MODULE AND KNOCK SENSOR

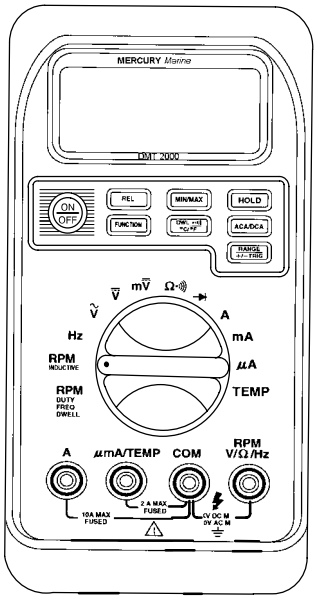
NOTE: *A digital volt-ohmmeter (DVOM) and an unpowered test light (low power test light - 300mA or less) are needed to conduct the following test.*

⚠ WARNING

Avoid fire or explosion. Ensure that engine compartment is well ventilated and gasoline vapors are not present when performing electrical tests inside the engine compartment. Sparks generated by electrical tests could ignite gasoline vapors causing fire or explosion.

IMPORTANT: The correct knock module and sensor must be used. Using an incorrect knock module or sensor will result in unrecognized spark knock and engine damage.

1. Start engine and warm it up to normal operating temperature.
2. Connect the positive (+) lead from the DMT to the PUR/WHT timing terminal that comes from the engine harness.

DMT 2000A Tachometer / Multi-Meter Kit		
 77959	Measures rpm on both 2 and 4 cycle marine engines, records the maximums and minimums simultaneously and will read accurately in high RFI environments. Replacement components: 91-854010-1 Inductive Pick-Up 8 ft (2.4 m) 91-854011-1 Temperature Probe 91-854012 Ferrite Core 91-854013-1 Interface Module 91-854014-1 Hard Carrying Case 91-854015-1 User's Guide 91-802651 Test Leads Optional Accessories: 84-854016T 8 ft. (2.4 m) Inductive Pick-Up Extension 91-802650-1 Clamp-On Current Probe 91-89045-1 Direct Voltage Adapter	91-854009A3

3. Connect the negative (–) lead from the DVOM to a good engine ground (–).
4. With the engine operating, there should be 8-10 volts on this circuit. If voltage is not present, ensure that there is 12 volts to the knock module (PUR wire Terminal "B").
5. Advance the throttle to approximately 1500 rpm.
6. Disconnect the harness connector (BLU wire) from the knock sensor.

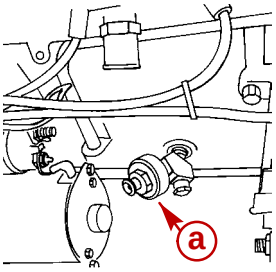
7. Connect the unpowered test light to a positive (+) 12 volt source.
8. To simulate an AC voltage, rapidly tap the knock sensor harness terminal with test light.
9. If knock module and wiring is functioning properly, voltage should drop on the DVOM. If a voltage does not drop, check the BLU wire from the sensor to the knock module for a short or open circuit. If the circuit is functioning properly to this point, the knock sensor may not be functioning.
10. Reconnect the knock sensor harness connector to the sensor.
11. While still observing the DVOM, lightly and rapidly tap on the engine block near the knock sensor with a small hammer. If the knock sensor is functioning properly, voltage should decrease. If voltage does not drop, the knock sensor is faulty.

INSTALLATION OF KNOCK SENSOR

IMPORTANT: The correct knock module and sensor must be used. Using an incorrect knock module or sensor will result in unrecognized spark knock and engine damage.

IMPORTANT: It is very important that the knock sensor be torqued to the exact specification. Incorrect torquing will result in unsatisfactory performance. Do not use sealer on threads.

1. Install and torque knock sensor in engine block.



73756

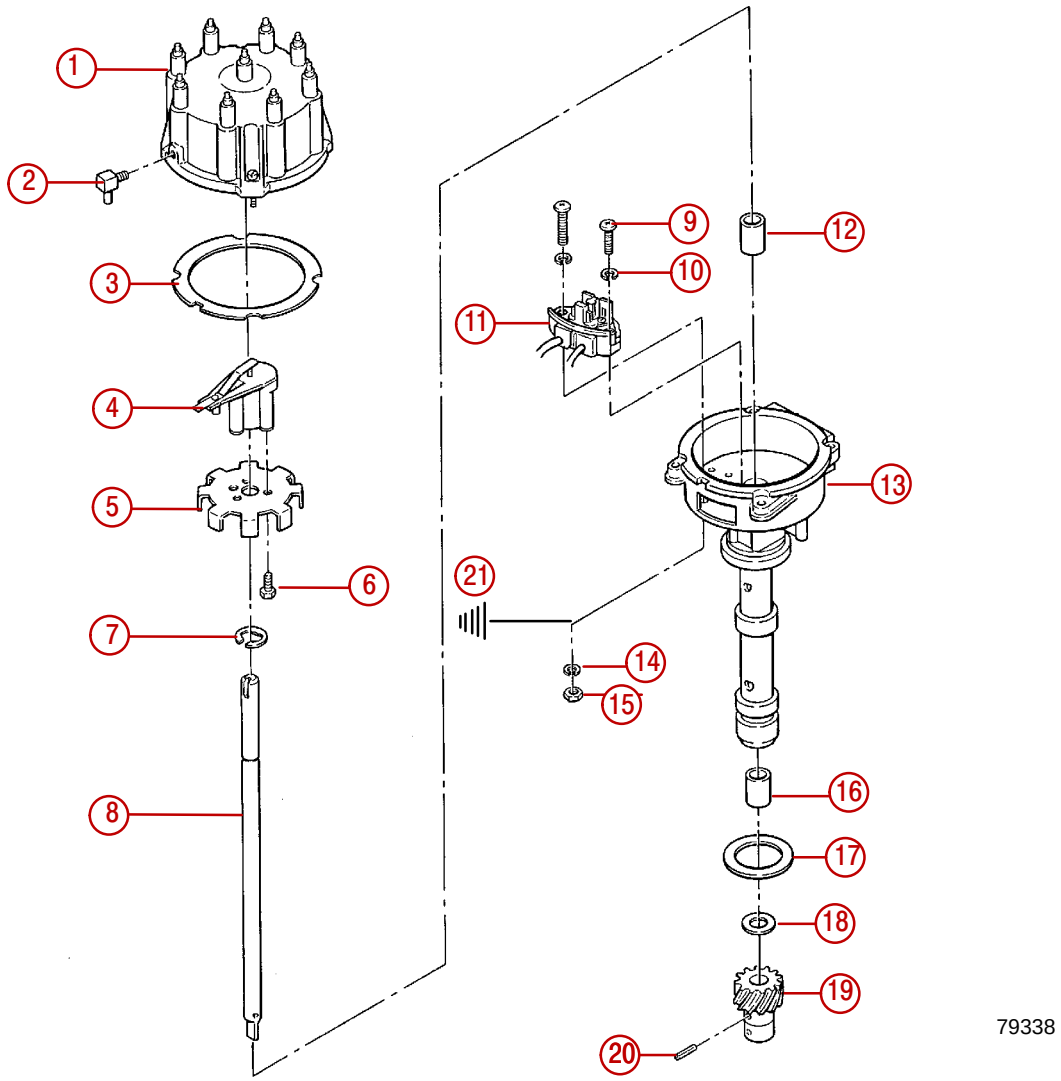
a - Knock sensor

Description	Nm	lb-in.	lb-ft
Knock sensor	18.9		14

2. Connect electrical connector to knock sensor.

Distributor

Exploded View



1 - Distributor cap
2 - Vent
3 - Gasket
4 - Rotor
5 - Senor wheel
6 - Screws (5)
7 - E-Clip
8 - Shaft
9 - Screws (2)
10 - Lockwashers (2)
11 - Sensor
12 - Upper bushing
13 - Distributor housing
14 - Lockwasher
15 - Nut
16 - Lower bushing
17 - Gasket
18 - Washer
19 - Gear
20 - Roll pin
21 - Ground lead

Distributor Cap

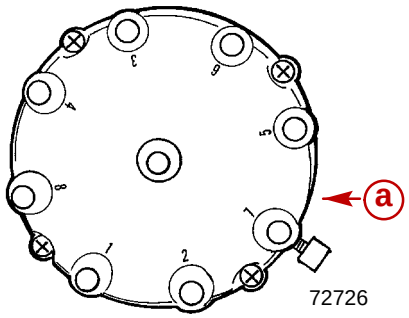
Removal

1. Loosen the distributor cap retaining screws.
2. Lift cap away from distributor.

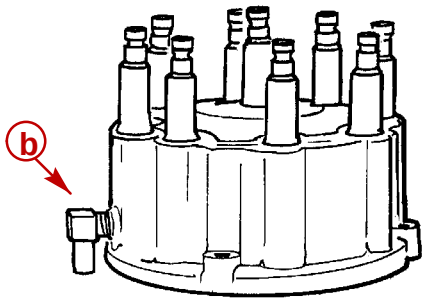
Cleaning and Inspection

1. Check cap contacts for excessive burning or corrosion.
2. Check center contact for damage.
3. Check cap for cracks or carbon tracks.
4. Clean cap with soap and warm water. Dry with compressed air.

IMPORTANT: If high tension leads are removed from cap refer to Spark Plug Wires and the following illustrations for installation.



72726



72728

a - Alignment notch
a - Vent

IMPORTANT: Use only a distributor cap recommended for marine application.

1. Install distributor cap by aligning tab in distributor cap with notch on distributor body. Tighten the retaining screws.

NOTE: *Use care when removing spark plug wires and boots from distributor cap. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the* ***boot*** *to remove wire end.*

2. For best results, individually transfer spark plug wires to replacement cap in order of removal.

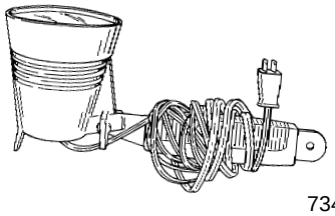
Rotor, Sensor, and Wheel

Removal

⚠ WARNING

Wear protective gloves when handling heated rotor / sensor wheel assembly to avoid severe burns.

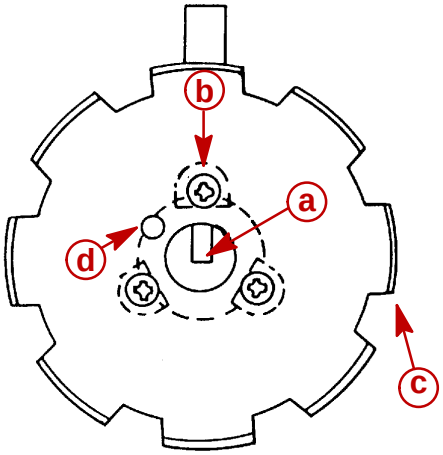
1. Remove distributor rotor / sensor wheel assembly from distributor shaft using 2 flat blade screwdrivers. Position the screwdrivers opposite each other with the blade tips contacting the shaft. A downward push on both screwdriver handles at the same time will pry off rotor / sensor wheel assembly. The use of a torch lamp will also aid in the removal of the rotor / sensor wheel assembly.

Torch Lamp		
 73437	120v Torch Lamp, heats the bearing bores to make the bearing removal and installation easier. 120v Replacement bulb 91-63210 ***NOTE:*** *240v Torch Lamp 91-74042 is no longer available. Replacement 240v bulb 88-68664 is available.*	91-63209

Cleaning and Inspection

1. Inspect the locating key inside the rotor. The locating key will appear as a clean edged, 3 mm (1/8 in.) wide, sloped ramp at the bottom of the splined hole.

   a. If there is any doubt that sensor wheel is located properly, lay sensor wheel on top of the diagram with sensor fingers facing up (toward you). Line up 3 screw holes and locating pin hole on sensor wheel with the diagram. If sensor wheel is indexed properly all the sensor fingers will line up with those in the diagram.



72730

Sensor wheel diagram

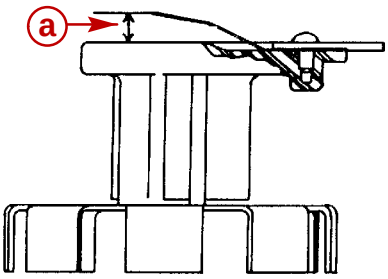
a - Locating key
b - Screws
c - Senor wheel
d - Locating pin

2. Check rotor for burned or corroded center contact or damaged key.
3. Check rotor for cracks and carbon tracks.

Installation

NOTE: *Rotor/sensor wheel are sold as an assembly only.*

1. Ensure that carbon brush tang has a 6 mm (1/4 in.) gap between rotor and tang.



72731

a - 6 mm (1/4 in.) gap

2. Put 2 drops of sealant into the rotor so it lands on the locating key.

Description	Where Used	Part Number
Loctite 271 Threadlocker	Rotor locating key	92-809819

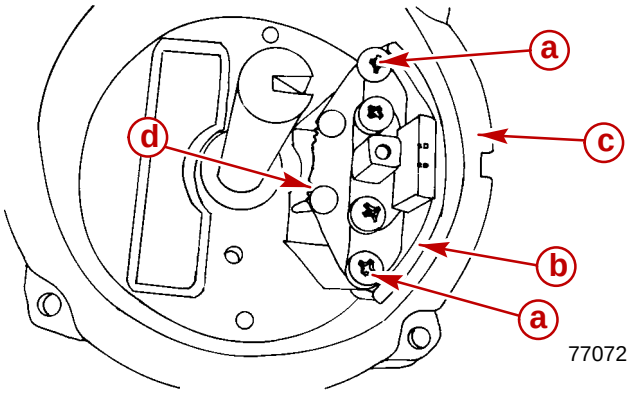
3. Put 2 drops of sealant in keyway on upper portion of distributor shaft.

Description	Where Used	Part Number
Loctite 271 Threadlocker	Distributor shaft keyway	92-809819

4. Immediately install rotor assembly onto distributor shaft.
   a. Ensure rotor locating key is aligned with keyway in distributor shaft. Press rotor down on the shaft with your hand until it stops.
5. Let sealant cure overnight with distributor in inverted position.

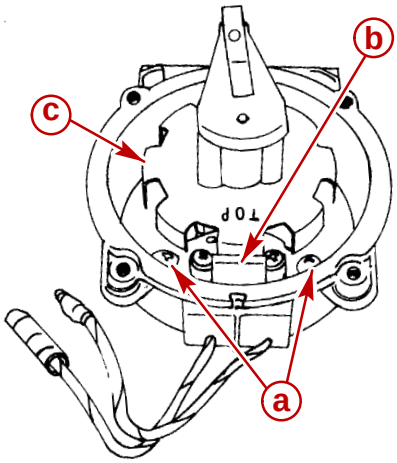
IMPORTANT: The rotor should fit very tight. It may be necessary to heat rotor with heat lamp to properly install. Do not let any Loctite run down distributor shaft. Loctite could get into top distributor housing bushing.

6. During installation, push sensor outward until the rubber gasket is slightly compressed against the distributor housing then tighten the sensor mounting screws



a - Mounting screws
b - Rubber gasket on sensor
c - Distributor housing
d - Sensor

IMPORTANT: Ensure that the fingers of the sensor wheel are not touching the sensor when the wheel is rotated.



a - Mounting screws
b - Sensor
c - Sensor wheel fingers

7. Reinstall distributor cap on distributor.

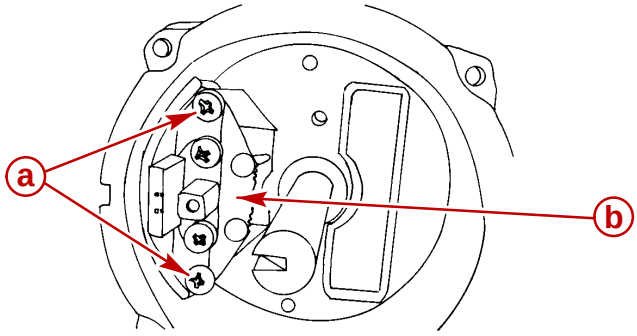
Sensor

TESTING

1. Disconnect the 2 sensor wires from the wiring harness.
2. Using an Ohmmeter, check for an ohm reading between the 2 sensor wires. If reading is less than 100 ohms, replace sensor.

REMOVAL

1. Remove rotor and sensor wheel.
2. Disconnect sensor wires.
3. Remove 2 screws that hold sensor into distributor housing. Remove sensor from housing.

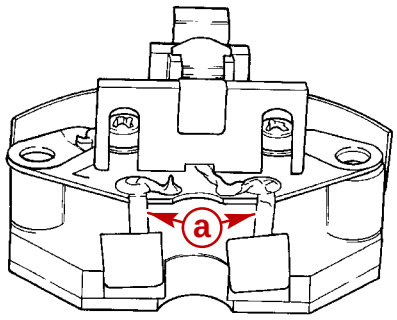


77072

a - Mounting screws
b - Sensor assembly

CLEANING AND INSPECTION

1. Use a magnifying glass and light to inspect the 2 metal jumper leads for cracks. If a crack is found in either metal jumper lead, install a new sensor.



72733

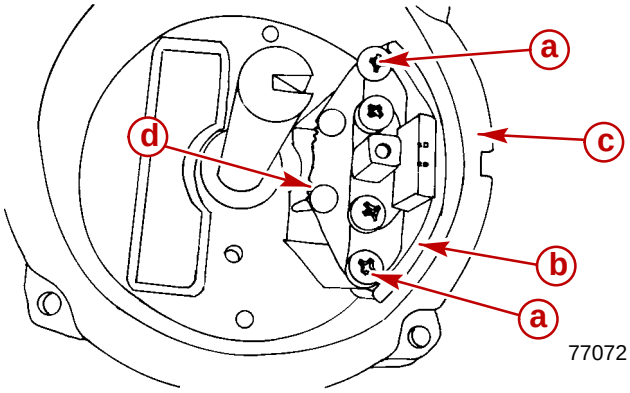
a - Jumper leads

⚠ CAUTION

Do not use any type of silicone sealer on the inside of the distributor. Most silicone sealers give off an acidic vapor during the curing stage of the sealer. This acid can cause corrosion on the ignition components.

INSTALLATION

1. Install sensor into housing and install 2 retaining screws.
2. Install sensor wheel, rotor, and distributor cap.
3. During installation, push sensor outward until the rubber gasket is slightly compressed against the distributor housing then tighten the sensor mounting screws



a - Mounting screws
b - Rubber gasket on sensor
c - Distributor housing
d - Sensor

4. Connect WHT/RED and WHT/GRN sensor wires (ring terminals on engine harness wires, or bullet connectors from ignition module wires). Tighten hex nuts securely (if equipped).

Distributor

Removal

NOTE: *One mounting screw protrudes through the distributor base and has a nut and washer. There is a ground lead attached to this screw.*

1. Unplug wiring harness from ignition module on distributor housing, or disconnect wires from ignition module mounted on exhaust elbow.
2. Disconnect sensor wires.
3. Remove distributor cap. Do not remove high tension leads unless necessary.
4. Crank engine over until timing marks line up and rotor is pointing toward No. 1 cylinder on distributor cap.
5. Mark distributor housing in reference to engine block.
6. Remove bolt and hold-down clamp and remove distributor.

IMPORTANT: To simplify distributor installation, do not turn crankshaft when distributor is removed from engine.

Disassembly

1. Remove rotor, sensor wheel, sensor, and ignition module (if mounted on distributor).
2. Remove roll pin, washer, and drive gear from distributor shaft.
3. Check for side play between shaft and distributor housing bushings. Maximum side play is 0.05 mm (0.002 in.).
4. Remove shaft from housing.
5. Check shaft for warp with a dial indicator and V-blocks. Maximum runout is 0.5 mm (0.002 in.).

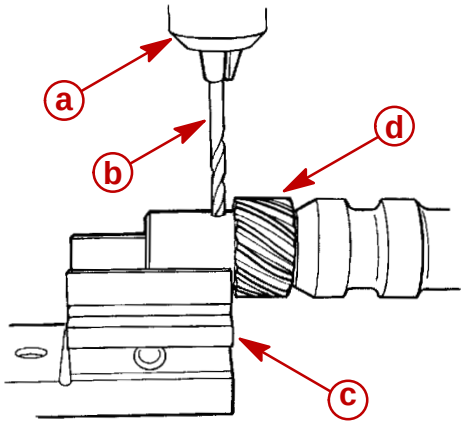
Reassembly

1. Lubricate distributor shaft with engine oil.
2. Install E-clip (if removed) on distributor shaft in housing.
3. Install washer on distributor shaft.
4. Install original drive gear; slide onto distributor shaft and install roll pin.

IMPORTANT: Hole may be offset and drive gear will only fit in one direction.

5. If installing a new drive gear, the gear will come drilled on one side. Slide drive gear onto distributor shaft; align hole in gear with hole in distributor shaft.
6. Using these holes as guides, drill through other side of drive gear with a 3/16 in. carbide tipped drill.

IMPORTANT: If a new drive gear has only a dimple, you will have to drill through one side of the gear before you slide gear onto shaft. In most cases it is recommended to have a machine shop complete the drilling operation for new drive gear installation.



72735

a - Drill press
b - 3/16 in. carbide tip drill
c - V-block
d - New drive gear

7. Install sensor, sensor wheel, rotor and ignition module (if mounted on distributor)
8. Install distributor.

Installation

1. Locate No. 1 piston in firing position by following instructions a. or b.:
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder.
   b. Continue cranking until pointer lines up with timing mark on crankshaft pulley.
   c. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.

IMPORTANT: Ensure that the oil pump shaft is engaged in the following. Position (align) oil pump shaft end to engage bottom of distributor drive gear prior to inserting distributor if necessary.

3. Position rotor to point toward No. 1 cylinder on cap (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more and work distributor down to engage camshaft and oil pump shaft. It may be necessary to rotate rotor slightly until engagement is felt.

⚠ CAUTION

Avoid severe engine damage. Do not attempt to force distributor into position using hold-down clamp and bolt.

4. When distributor housing contacts intake manifold, camshaft and oil pump shaft are engaged.
5. Connect all disconnected wires.
6. Place distributor cap in position. Ensure that rotor lines up with terminal for No. 1 spark plug.
7. Install new gasket on distributor housing.
8. Install distributor cap.
9. Coat any exposed terminals with sealant.

Description	Where Used	Part Number
Liquid Neoprene	Electronic terminals	92-27511-3

Distributor Gear

Removal

1. Remove rotor and sensor wheel.
2. Remove roll pin, washer, and drive gear from distributor shaft.
3. Check for side play between shaft and distributor housing bushings. Maximum side play is 0.05 mm (0.002 in.).
4. Remove shaft from housing.
5. Check shaft for warp with a dial indicator and V-blocks. Maximum runout is 0.05 mm (0.002 in.).

Installation

1. Lubricate distributor shaft.

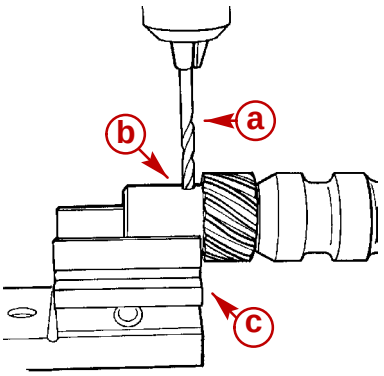
Description	Where Used	Part Number
Engine Oil	Distributor shaft	Obtain locally

2. Install E-clip on distributor shaft in housing.
3. Install washer on distributor shaft.
4. If installing original drive gear, slide onto distributor shaft and install roll pin.

IMPORTANT: Drive gear will only fit in one direction.

5. If installing a new drive gear, slide gear onto distributor shaft and align hole in drive gear with hole in distributor shaft.
6. Using these holes as a guide, drill through other side of drive gear with a 3/16 in. carbide tipped drill bit.

IMPORTANT: If drive gear only has a dimple, you MUST drill through one side of the gear before you slide it onto the distributor shaft. In most cases, it is recommended that you have a machine shop drill the new drive gear.



72735

a - 3/16 in. carbide tip drill bit
b - Drive gear
c - V-block

7. Install rotor and sensor wheel.
8. Install distributor.

ELECTRICAL SYSTEMS

Section 4C - MPI Ignition System

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4C

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on Mercury MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Specifications

Distributor

Description	Specification
Distributor (Part Number)	884794A02

Coil

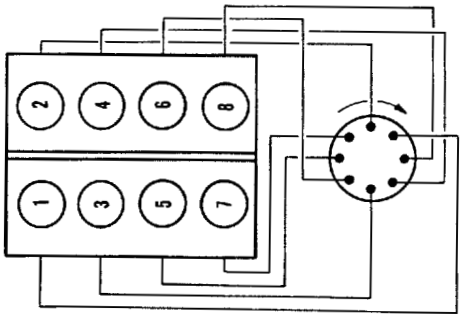
Description	Specification
Coil (Part Number)	392-863704T
Primary resistance	0.60-0.80 ohms
Secondary resistance	9,400-11,700 ohms

Spark Plugs

Description	Specification
Spark plug type	AC Platinum (AC 41-932)
	Champion RS14PYP6
Spark plug gap	1.5 mm (0.060 in.)

Specifications (continued)

Firing Order



72008

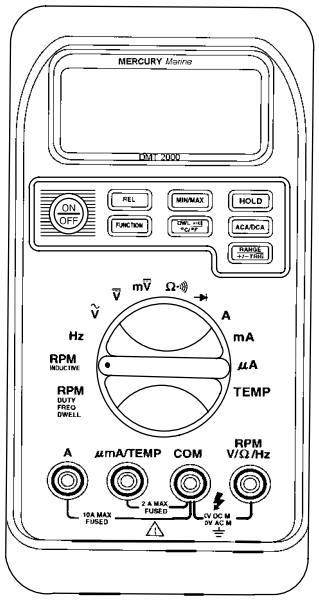
Description	Specification
Firing order	1-8-4-3-6-5-7-2

Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Tite Seal Compound	Coil high tension lead tower	92-41669--1
General Purpose Grease	Distributor shaft	Obtain locally

Equivalent products may be used.

Special Tools

DMT 2000A Tachometer / Multi-Meter Kit		
 77959	Measures rpm on both 2 and 4 cycle marine engines, records the maximums and minimums simultaneously and will read accurately in high RFI environments. Replacement components: 91-854010-1 Inductive Pick-Up 8 ft (2.4 m) 91-854011-1 Temperature Probe 91-854012 Ferrite Core 91-854013-1 Interface Module 91-854014-1 Hard Carrying Case 91-854015-1 User's Guide 91-802651 Test Leads Optional Accessories: 84-854016T 8 ft. (2.4 m) Inductive Pick-Up Extension 91-802650-1 Clamp-On Current Probe 91-89045-1 Direct Voltage Adapter	91-854009A3

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb-in.	lb-ft
Spark plugs (new cylinder head)	29.8		22
Spark plugs (all others)	14	132	
Distributor hold down clamp bolt	24.4		18

Finding Top Dead Center (TDC)

1. Locate No. 1 piston in firing position by following instructions a. or b.:
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley.
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.

Spark Plugs

Removal

1. Disconnect the spark plug wires (high tension leads) from the spark plugs.

NOTE: *Use care when removing the spark plug wires and boots from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the* ***boot*** *to remove the wire.*

2. Remove the spark plugs.

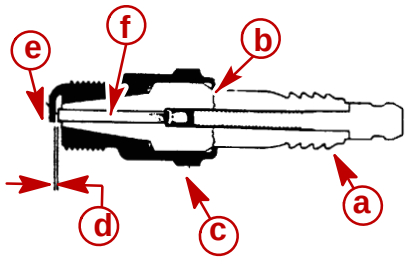
NOTE: *A thin-walled spark plug socket may be required.*

Inspection

1. Inspect each spark plug for the manufacturer and spark plug number. All plugs must be from the same manufacturer and have the same spark plug number.

Description	Specification
Spark plug type	AC Platinum (AC 41-932)
Spark plug type	Champion RS14PYP6

2. Inspect each plug individually for worn electrodes, and for glazed, broken, or blistered porcelain. Check the joint between the insulator and the shell for cracks. Replace as necessary.

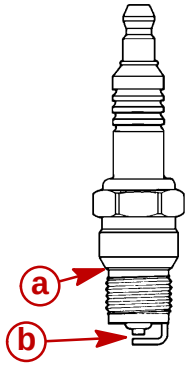


72734

a -Porcelain insulator
b -Insulator
c -Shell
d -Proper gap
e -Side electrode
f -Center electrode (when adjusting gap - do not bend)

Installation

1. Clean the spark plug seating area on the cylinder heads.
2. Adjust the spark plug gap with a round feeler gauge. Bend the side electrode to adjust the gap. Do not bend the center electrode.



75084

a -Seating area
b -Gap

Description	Specification
Spark plug gap	1.50 mm (0.060 in.)

IMPORTANT: Spark plugs should be torqued to the amount specified. In the absence of a torque wrench or access problems to the plugs, the spark plugs should be hand tightened until the plug seats on the cylinder head and then securely tightened with the appropriate ratchet and socket.

3. Install the spark plugs and torque.

Description	Nm	lb-in.	lb-ft
Spark plugs (new cylinder head)	29.8		22
Spark plugs (all others)	14	132	

4. Install the spark plug wires in the proper order.

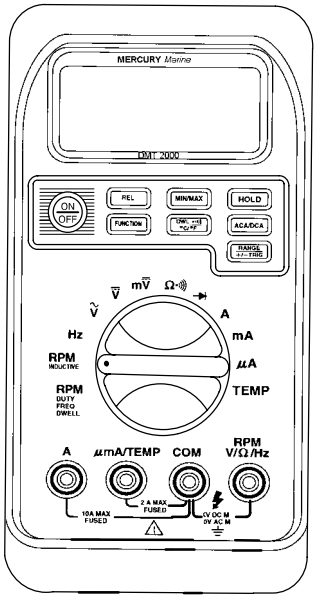
Spark Plug Wires

Inspection

1. Visually inspect the spark plug wires and the coil wire for damage.
2. Visually inspect the spark plug boots for damage.

NOTE: *Use care when removing the spark plug wires and the boots from the spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the* ***boot*** *to remove the wire end.*

3. Check the spark plug wires and the coil wire for continuity using a multi-meter.

DMT 2000A Tachometer / Multi-Meter Kit		
 77959	Measures rpm on both 2 and 4 cycle marine engines, records the maximums and minimums simultaneously and will read accurately in high RFI environments. Replacement components: 91-854010-1 Inductive Pick-Up 8 ft (2.4 m) 91-854011-1 Temperature Probe 91-854012 Ferrite Core 91-854013-1 Interface Module 91-854014-1 Hard Carrying Case 91-854015-1 User's Guide 91-802651 Test Leads Optional Accessories: 84-854016T 8 ft. (2.4 m) Inductive Pick-Up Extension 91-802650-1 Clamp-On Current Probe 91-89045-1 Direct Voltage Adapter	91-854009A3

4. Replace any damaged wires.

Installation

IMPORTANT: Use only the spark plug wires recommended for marine applications.

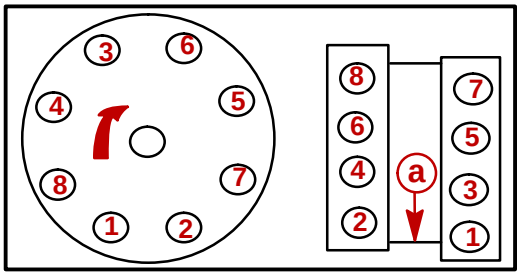
NOTE: *When replacing the spark plug wires, replace one wire at a time to reduce the risk of error.*

1. Disconnect the individual spark plug wires.

IMPORTANT: When replacing the plug wires, route the wires correctly through the proper supports. Correct positioning of the spark plug wires and supports is important to prevent cross-firing.

IMPORTANT: When routing plug wires, route to avoid contact with all other electronic components.

2. Install the spark plug wires in the proper order.
   a. Position the wires in the spark plug wire supports and retainers.
   b. Attach the plug wires to the appropriate spark plug and terminal on the distributor cap. Each end should fit securely.



a - Front

IMPORTANT: Before installing the coil wire (high tension lead) to the coil, apply Tite Seal Compound around the top of the coil high tension lead tower. Do not apply to the inside of the tower hole.

   c. Apply sealant to the coil high tension lead tower. Attach the coil wire to the center terminal on the distributor cap and to the ignition coil.

Description	Where Used	Part Number
Tite Seal Compound	Coil high tension lead tower	92-41669--1

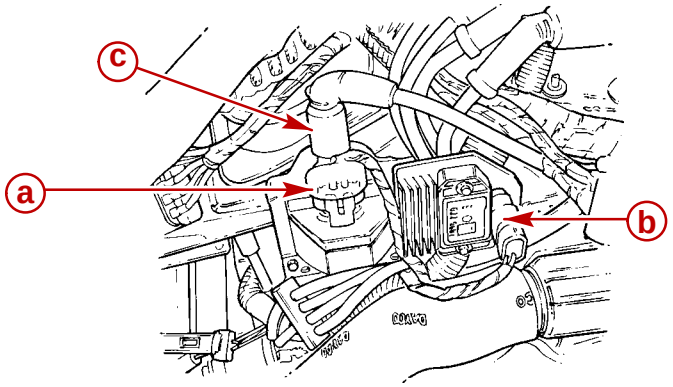
NOTE: *Ensure that the boot does not come off of the tower due to hydraulic air pressure inside the boot.*

   d. Push the end of the high tension wire into the coil tower. Position the boot over the coil tower and wipe off excess insulating compound.

Ignition Coil

Removal

1. Disconnect the wire harness connector at the ignition coil.
2. Disconnect the ignition module wire harness connector.
3. Remove the high tension coil lead.



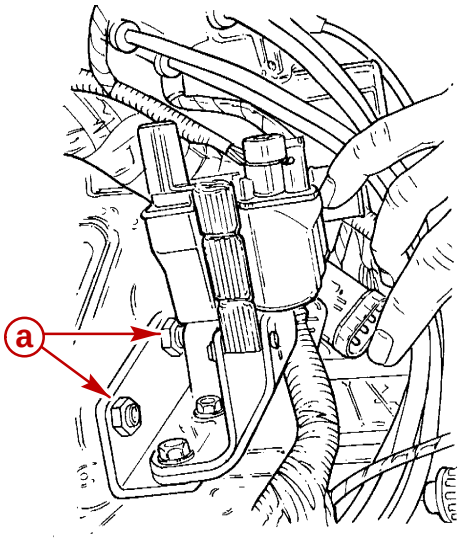
78032

a -Wire harness connection
b -Ignition module wire connection
c -High tension coil lead connection

4. Remove the coil bracket fasteners and remove the coil bracket assembly from the engine.
5. Remove the ignition coil from the coil bracket.

Installation

1. Install the coil bracket assembly to the engine bracket with the fasteners.

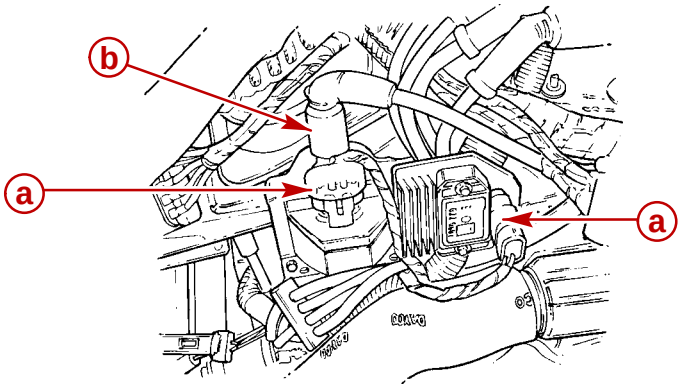


77922

a - Coil bracket fasteners

IMPORTANT: Before installing the coil wire (high tension lead) to the coil, apply Tight Seal Compound around the top of the coil high tension lead tower. Do not apply to the inside of the tower hole.

2. Connect the high tension coil lead.



78032

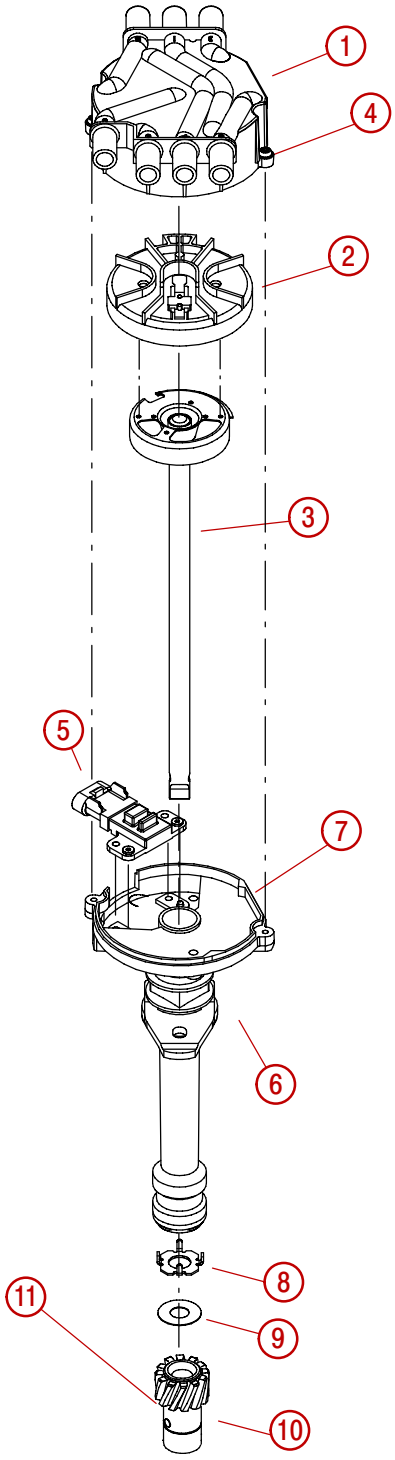
a - Wire harness connection
b - High tension coil lead connection

Description	Where Used	Part Number
Tite Seal Compound	Coil high tension lead tower	92-41669--1

3. Connect the wire harness connectors.

MPI Distributor (Excluding Scorpion Models)

Exploded View

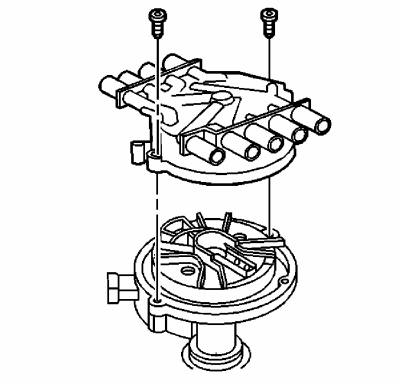


78115

1 - Distributor cap
2 - Rotor
3 - Shaft assembly
4 - Srew
5 - Module (not used)
6 - Housing
7 - Gasket
8 - Tang washer
9 - Washer
10 - Gear
11 - Pin

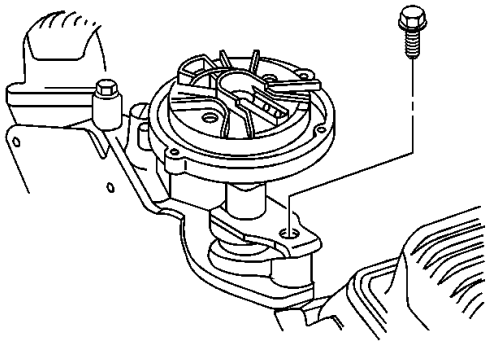
Removal

1. Verify that the engine is at cylinder 1 TDC.
1. Remove all spark plug wires.
2. Remove the 2 screws fastening the distributor cap to the distributor.
3. Remove the distributor cap and set it aside.



77855

4. To ease installation, mark the position of the distributor housing on the intake manifold.
5. Remove the bolt retaining the distributor.



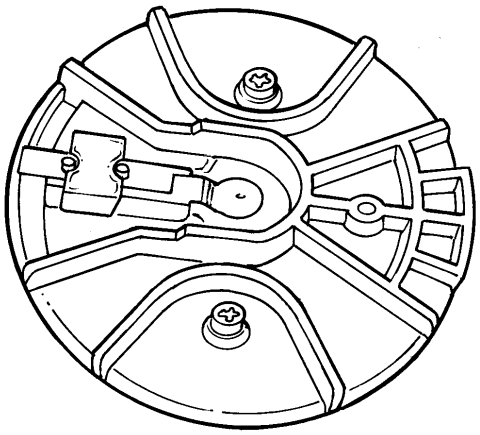
77850

6. Remove the distributor and the gasket from the intake manifold.

IMPORTANT: Ensure that the engine is at number 1 cylinder top dead center before installing the distributor.

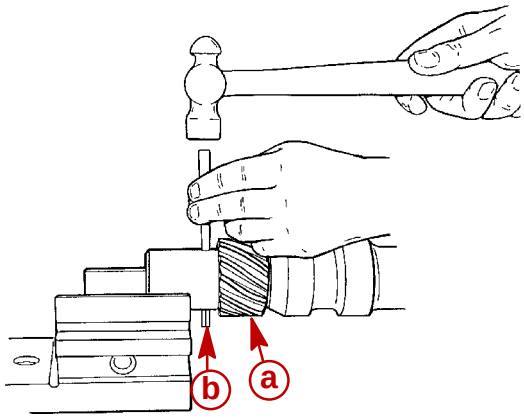
Disassembly

1. Remove the rotor from the distributor shaft by removing 2 torx fasteners.



77918

2. Remove the roll pin.



72917

a -Drive gear
b -Roll pin

3. Remove the gear, the washer, and the tang washer.
4. Remove the shaft assembly from the housing.

Cleaning and Inspection

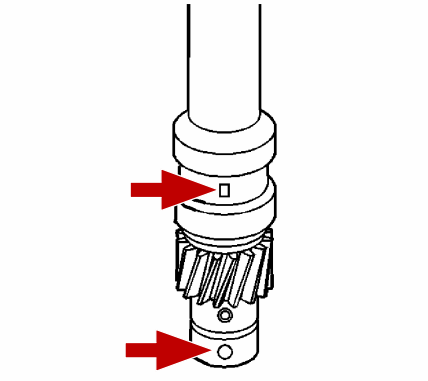
1. Visually inspect the distributor cap for cracks or carbon tracks. Replace the distributor cap if it shows any sign of damage.
2. Check the metal terminals in the cap for evidence of corrosion. Use a knife to scrape surfaces clean. If the corrosion is deep, replace the distributor cap.
3. Inspect for signs of wear or burning at the outer terminal of the rotor. The presence of carbon on the terminal indicates serious rotor wear and the need for replacement.
4. Inspect the distributor shaft for shaft-to-bushing looseness. Insert the shaft in the housing. If the shaft wobbles, indicating a loose fit, replace the housing and/or shaft.
5. Clean the metal parts in solvent and dry with compressed air.
6. Check the housing for signs of cracks or damage; replace if necessary.

Reassembly

1. Lubricate the distributor shaft with grease and install into the housing.

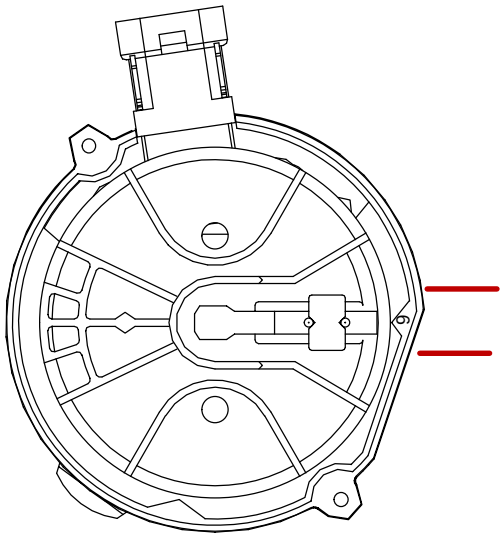
Description	Where Used	Part Number
General Purpose Grease	Distributor shaft	Obtain locally

2. Install the tang washer, the washer and the drive gear onto the shaft.
3. Temporarily install the rotor on the shaft. Align the scribe marks on the gear, the housing, and the rotor.
4. Install the roll pin through the gear and the distributor shaft.
5. Spin the distributor shaft to ensure that it spins freely.
6. Align the distributor shaft keyways.



77851

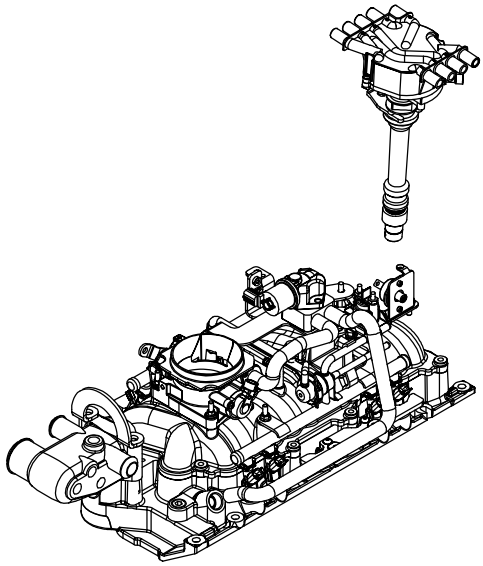
7. Install the rotor onto the distributor shaft. Ensure that the engine is at number 1 cylinder TDC, the tang must be aligned between the 2 marks.



78144

Installation

1. Verify that the engine is at cylinder 1 TDC. Verify that the rotor tang is in the proper location.
2. Align distributor to the opening in the block.



77951

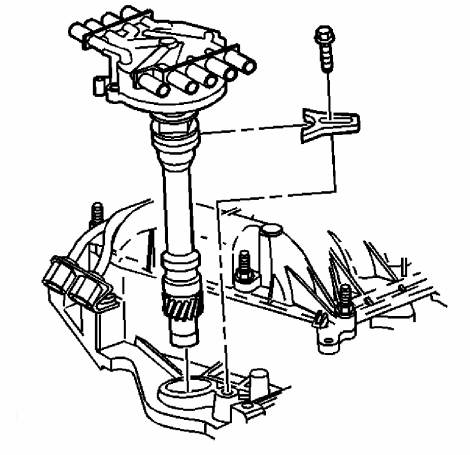
IMPORTANT: Ensure that the oil pump shaft is engaged in the following. Position (align) oil pump shaft end to engage bottom of distributor drive gear prior to inserting distributor if necessary.

3. Position rotor to point toward No. 1 cylinder on cap (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more and work distributor down to engage camshaft and oil pump shaft. It may be necessary to rotate rotor slightly until engagement is felt.

⚠ CAUTION

Avoid severe engine damage. Do not attempt to force distributor into position using hold-down clamp and bolt.

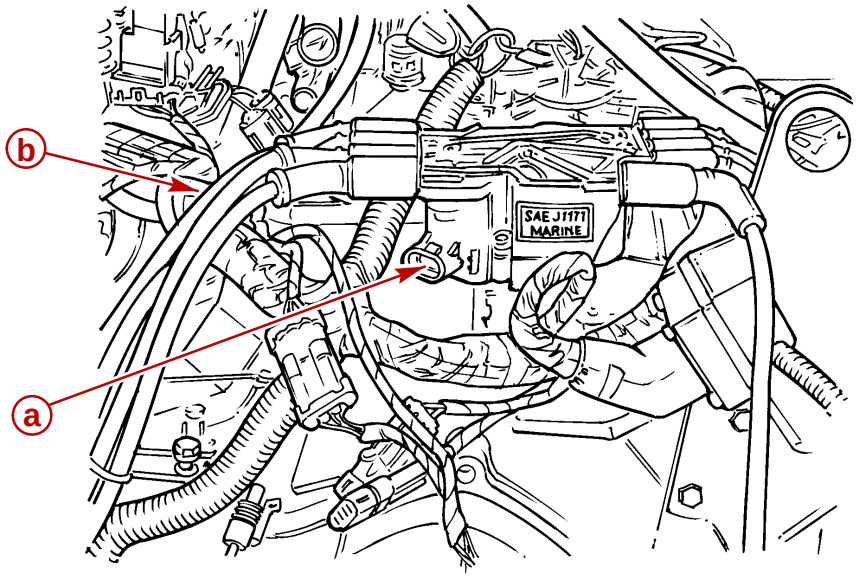
4. When distributor housing contacts intake manifold, camshaft and oil pump shaft are engaged.
5. Install the hold-down clamp over the distributor and bolt it securely to the engine surface. Torque the bolt.



77858

Description	Nm	lb-in.	lb-ft
Distributor hold down clamp bolt	24.4		18

6. Install the distributor cap and secure in place with two torx fasteners.
7. Connect the spark plug wires.

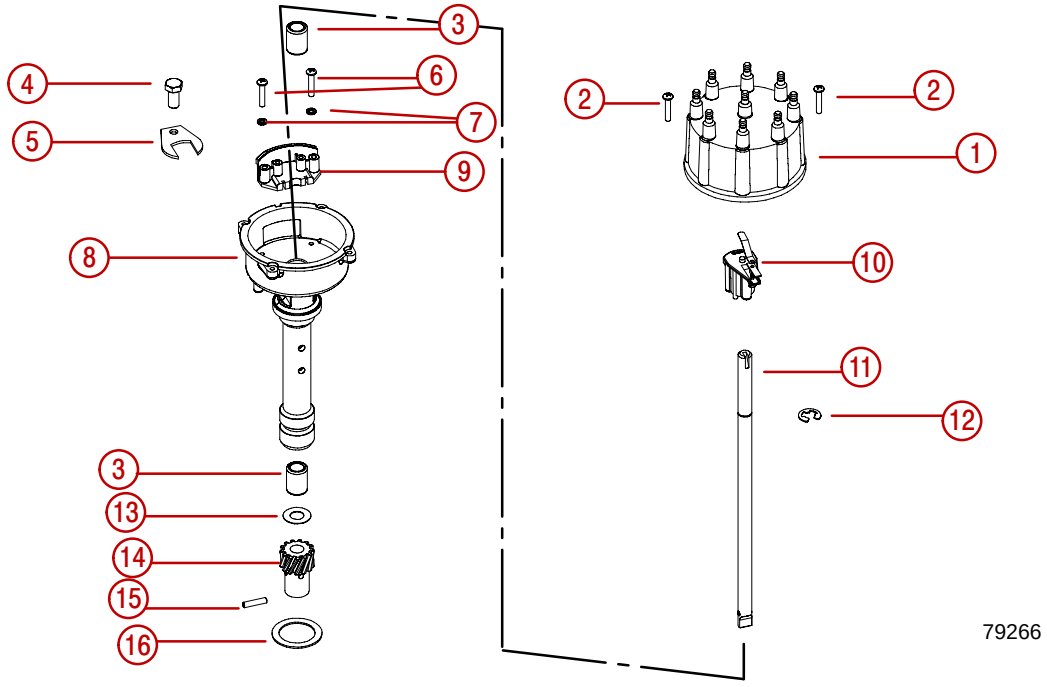


77923

a - Plug not used
b - Spark plug wires

Scorpion Distributor

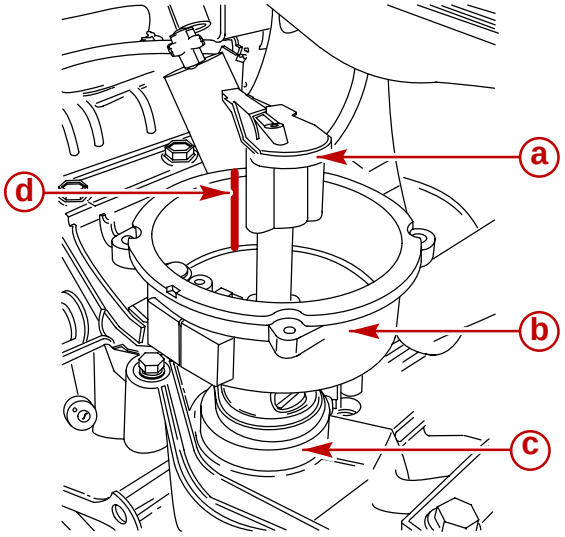
Exploded View



1 - Distributor cap
2 - Distributor cap screw
3 - Bearing sleeve
4 - Distributor hold down clamp
5 - Distributor hold down clamp screw
6 - Terminal block screw
7 - Terminal block washer
8 - Distibutor housing
9 - Terminal block
10 - Rotor
11 - Distributor shaft
12 - E–clip
13 - Washer
14 - Drive gear
15 - Pin
16 - Gasket

Removal

1. Verify that the engine is at cylinder 1 TDC.
2. Remove distributor cap and set it aside. Do not remove high tension leads unless necessary.
3. Paint a line on distributor housing marking position of the rotor.



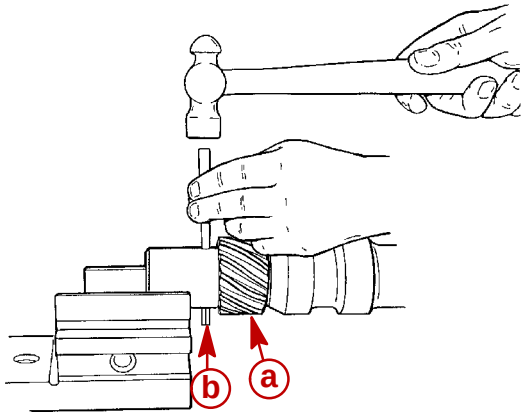
79331

a - Rotor
b - Distributor housing
c - Intake manifold
d - Paint mark

4. Remove bolt and hold-down clamp.
5. Remove distributor and gasket from intake manifold.

Disassembly

1. Remove rotor from distributor shaft by lifting or prying straight up.
2. Remove roll pin.



72917

a -Drive gear
b -Roll pin

3. Remove drive gear and washer.

Cleaning and Inspection

1. Visually inspect the distributor cap for cracks or carbon tracks. Replace the distributor cap if it shows any sign of damage.
2. Check metal terminals in the distributor cap for evidence of corrosion. Use a knife to scrape surfaces clean. If corrosion is deep, replace the distributor cap.
3. Look for signs of wear or burning at the outer terminal of the rotor. Presence of carbon on the terminal indicates serious rotor wear and need for replacement.
4. Check for side play between shaft and distributor housing bushings. Maximum side play is 0.05 mm (0.002 in.).
5. Remove shaft from housing.
6. Check shaft for warp with a dial indicator and V-blocks. Maximum runout is 0.05 mm (0.002 in.).
7. If the shaft is not within specifications replace the housing and/or shaft.
8. Clean metal parts in solvent and dry with compressed air.
9. Check housing for signs of cracks or damage; replace if necessary.

Reassembly

1. Lubricate distributor shaft with grease and install into housing.

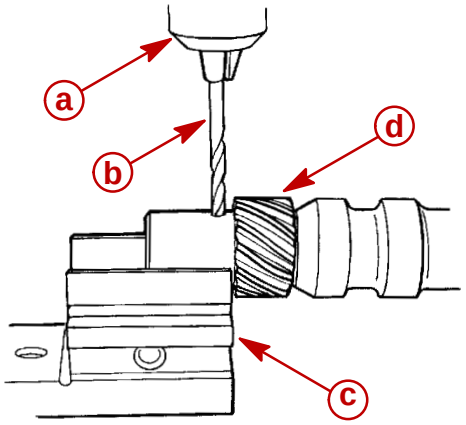
Description	Where Used	Part Number
General Purpose Grease	Distributor shaft	Obtain locally

2. Install E-clip (if removed) on distributor shaft in housing.
3. Install washer on distributor shaft.
4. Install original drive gear; slide onto distributor shaft and install roll pin.

IMPORTANT: Hole may be offset and drive gear will only fit in one direction.

5. If installing a new drive gear, the gear will come drilled on one side. Slide drive gear onto distributor shaft; align hole in gear with hole in shaft.
6. Using these holes as guides, drill through other side of drive gear with a 3/16 in. carbide tipped drill.

IMPORTANT: If a new drive gear has only a dimple, you will have to drill through one side of the gear before you slide gear onto distributor shaft. In most cases it is recommended to have a machine shop complete the drilling operation for new drive gear installation.



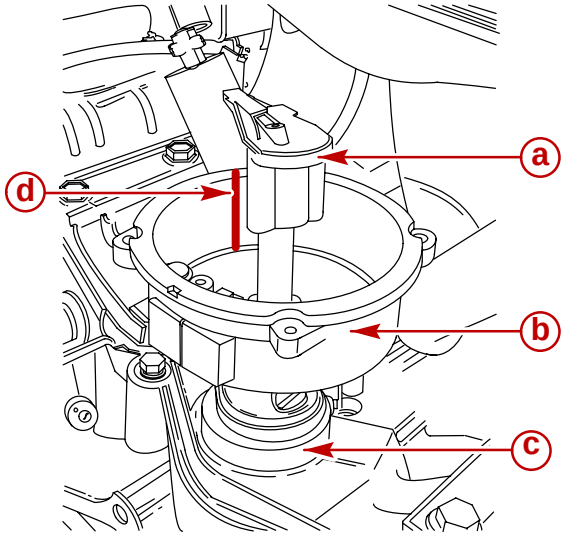
72735

a - Drill press
b - 3/16 in. carbide tip drill
c - V-block
d - New drive gear

7. Install rotor on the distributor shaft and install the distributor.

INSTALLATION

1. Verify that the engine is at cylinder 1 TDC.
2. Align rotor, with the distributor housing using the paint mark.



79331

a -Rotor
b -Distributor housing
c -Intake manifold
d - Paint mark inside distributor housing

3. Slowly lower distributor (with gasket) through intake manifold and into position. If distributor shaft will not drop into position, pull it out and insert a screwdriver into the hole to turn the oil pump drive shaft. Repeat this adjustment as many times as needed until the distributor can be firmly seated and all components are in alignment.
4. Install hold-down clamp over distributor and bolt it securely to engine surface. Torque the bolt.

Description	Nm	lb-in.	lb-ft
Distributor hold down clamp bolt	24.4		18

5. Install distributor cap and secure in place with 2 screws.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

6. Provide sufficient water supply to water inlet holes.
7. Start engine. Ensure that system is operating correctly.

NOTES:

ELECTRICAL SYSTEM

Section 4D - Charging System

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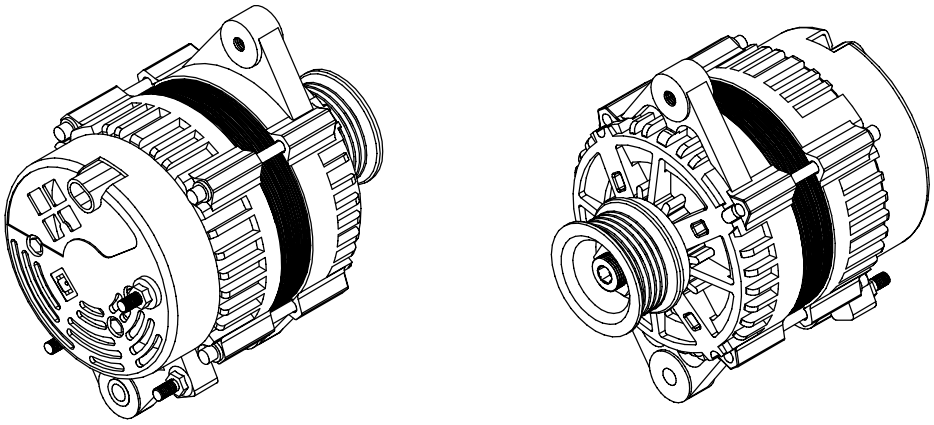
4 D

Delco Alternator



78134

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on Mercury MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

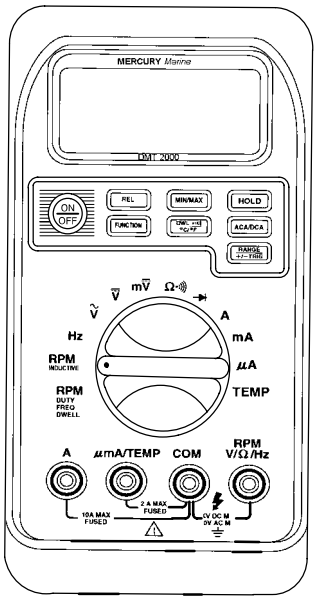
Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Specifications

Description	Specification
Excitation circuit	1.3 to 2.5 volts
Current output	60 amp minimum
Voltage output	13.9 to 14.7 volts
Minimum brush length	6 mm (1/4 in.)

Special Tools

DMT 2000A Tachometer / Multi-Meter Kit		
 77959	Measures rpm on both 2 and 4 cycle marine engines, records the maximums and minimums simultaneously and will read accurately in high RFI environments. Replacement components: 91-854010-1 Inductive Pick-Up 8 ft (2.4 m) 91-854011-1 Temperature Probe 91-854012 Ferrite Core 91-854013-1 Interface Module 91-854014-1 Hard Carrying Case 91-854015-1 User's Guide 91-802651 Test Leads Optional Accessories: 84-854016T 8 ft. (2.4 m) Inductive Pick-Up Extension 91-802650-1 Clamp-On Current Probe 91-89045-1 Direct Voltage Adapter	91-854009A3

Tools

Description	Part Number
Ammeter (0-100 amp)	Obtain locally

Precautions

The following precautions MUST BE observed when working on the charging system. Failure to observe these precautions may result in serious damage to the alternator or charging system.

1. Do not attempt to polarize the alternator.
2. Do not short across or ground any of the terminals on the alternator, except as specifically instructed in the Troubleshooting Tests.
3. NEVER disconnect the alternator output lead or battery cables when the alternator is operating.
4. NEVER disconnect the regulator lead from the alternator regulator terminal when the alternator is operating.
5. When installing the battery, BE SURE to connect the positive (+) battery cable to the positive (+) battery terminal and the negative (–) (grounded) battery cable to the negative (–) battery terminal.
6. If a charger or booster battery is to be used, connect it in parallel with the existing battery (positive to positive; negative to negative).

EFI Electrical System Precautions

⚠ CAUTION

Avoid damage to the EFI electrical system and components. Refer to the following precautions when working on or around the EFI electrical harness or when adding other electrical accessories:

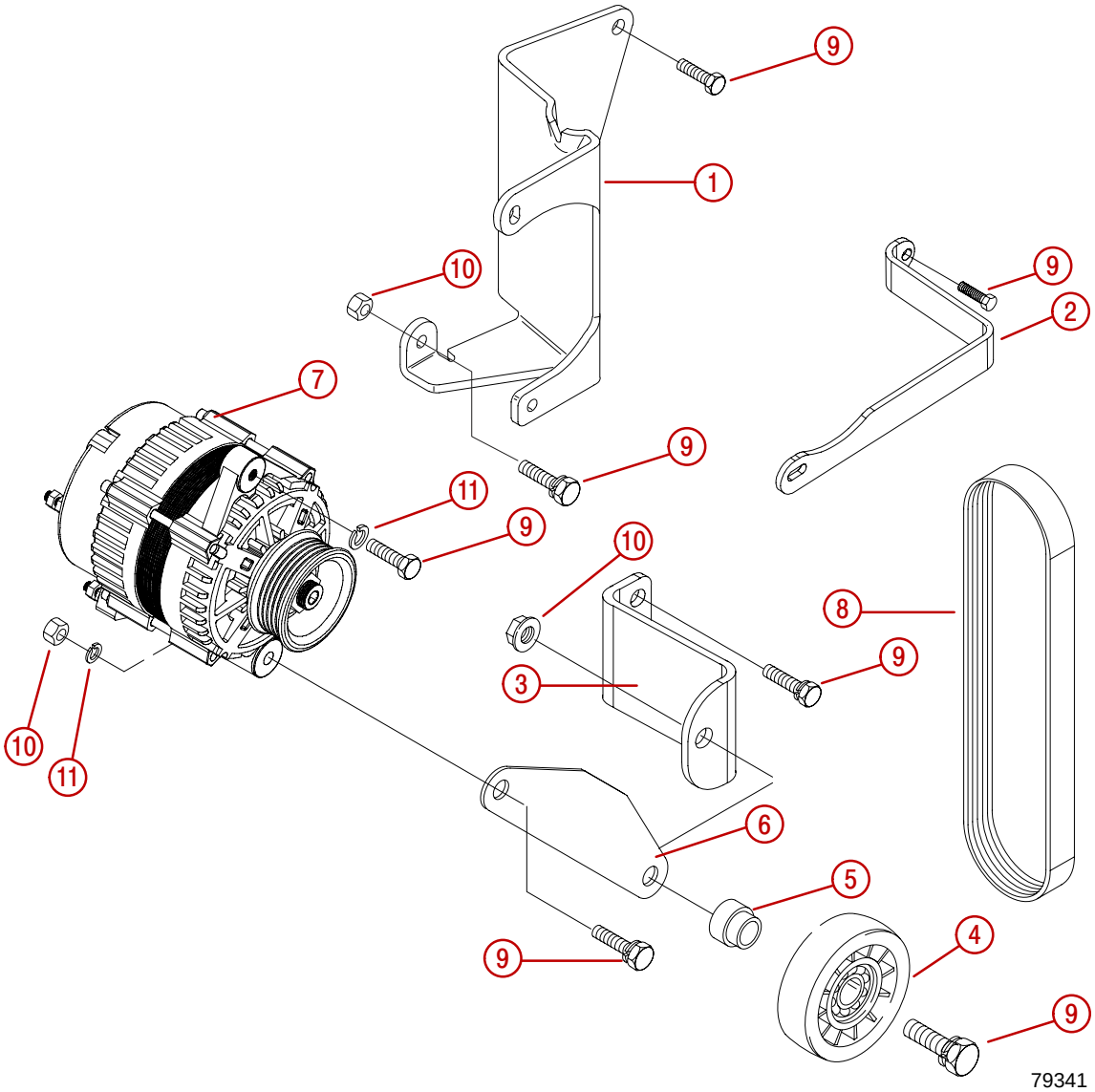
- **Do not tap accessories into the engine harness.**
- **Do not puncture wires for testing (Probing).**
- **Do not reverse the battery leads.**
- **Do not splice wires into the harness.**
- **Do not attempt diagnostics without proper, approved Service Tools.**

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

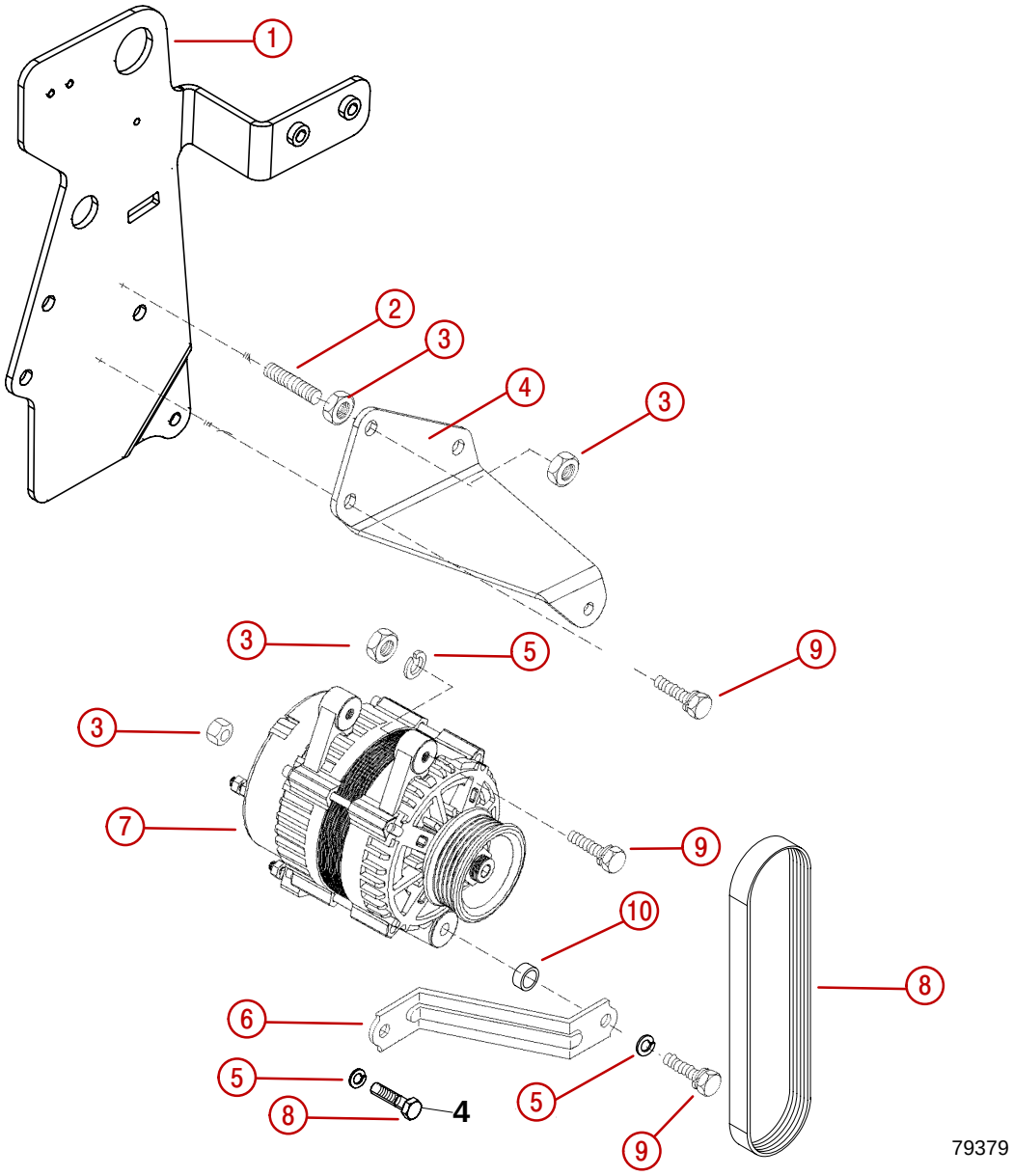
Exploded Views

Sterndrive Models



1 - Alternator mounting bracket
2 - Alternator brace (Alpha models standard cooling)
3 - Idler pulley bracket
4 - Idler pulley
5 - Idler pulley bushing
6 - Alternator brace (Bravo models and Alpha closed cooled models)
7 - Alternator
8 - Serpentine belt
9 - Screw
10 - Nut
11 - Washer

Inboard Models



1 - Lifting eye bracket
2 - Stud
3 - Nut
4 - Alternator brace
5 - Washer
6 - Alternator to engine brace
7 - Alternator
8 - Serpentine belt
9 - Screw
10 - Spacer

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb-in.	lb-ft
Alternator to mounting bracket	47.4		35
Alternator mounting bracket	40.6		30
Belt tension	See Note		
Battery nut terminal	7	62	
Mounting bolts	10	96	

NOTE: *Belt deflection is to be measured on the belt at the location that has the longest distance between 2 pulleys. Refer to Section 1B.*

Charging System Components

The charging system consists of the alternator, the battery, the ignition switch, and the wiring that connects these components.

Periodic Maintenance

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Inspect the entire alternator system for corroded or loose connectors.
2. Check the wiring for frayed or worn insulation.
3. Check the alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Also, check the drive belt tension and adjust.
4. Check the alternator mounting bolts for adequate tightness.

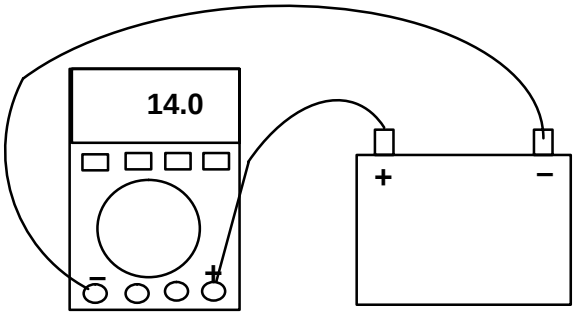
Troubleshooting Tests (Alternator on Engine)

Use the following tests in conjunction with SECTION 1C - Troubleshooting. Before proceeding with the tests, perform the following checks to eliminate possible problem areas. Observe the Precautions to prevent damage to the alternator system.

1. An undercharged battery can be caused by excessive current draw, from accessories or by operating the engine at low speeds for extended periods.
2. Check the physical condition and the battery charge. The battery MUST BE at least 75 percent (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge the battery before testing the system.
3. Inspect the entire charging system wiring for defects. Ensure that all connections are secure and clean.
4. Check the alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Replace if necessary. Also, check the drive belt tension and adjust if necessary.

Charging System

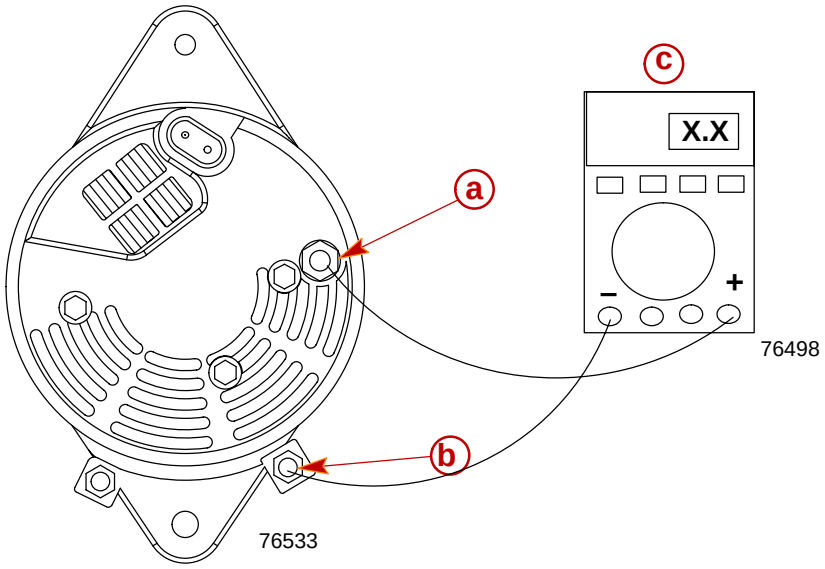
1. Check the belt condition and tension.
2. Check the battery condition.
3. With a fully charged battery, connect the voltmeter leads directly to the battery posts.



76498

4. Supply cooling water to the engine.
5. Start the engine and operate at 1300-1500 rpm. Read the voltmeter in VDC position. Most systems will read 13.8-14.8 volts.
6. If the reading is between 13.5 and 14.8 volts, switch the DVOM to the AC volt position. and observe. A reading of 0.25 AC volts or less indicates that the alternator diodes are fully functional. A reading above 0.25 AC volts indicates that the diodes are faulty and the alternator must be replaced.
7. If the reading is below 13.5 volts:
   a. Connect the positive (+) voltmeter lead to the alternator output post.

b. Connect the negative (–) lead to the ground post on the alternator.



Typical

a - Output terminal
b - Ground terminal
c - Voltmeter

c. Wiggle the engine wiring harness while observing the voltmeter. The meter should indicate the approximate battery voltage and should not vary. If no reading is obtained, or if the reading varies, refer to Resistance.

d. If the reading is above 15 volts, the alternator is overcharging and must be replaced.

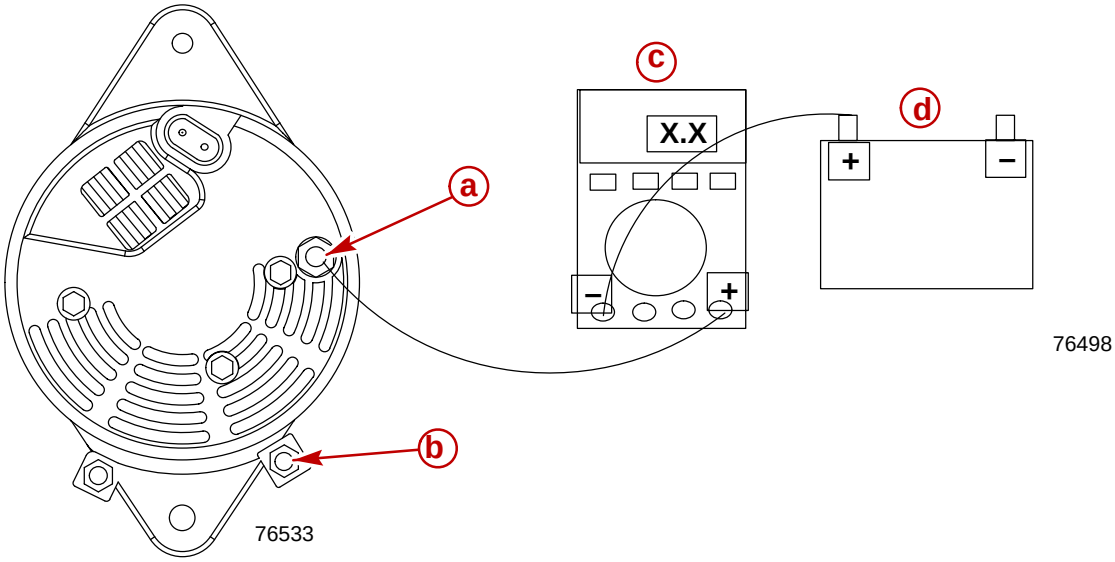
e. If the voltmeter reading is now within specifications, there is too much resistance between the alternator and the battery.

f. If the reading is below 12.5 volts, the alternator may not be charging. Check all wiring leading to the alternator.

Resistance

1. Disconnect the coil wire so that the engine does not start.
2. Crank the engine over for 15 seconds to discharge the battery slightly.
3. Reconnect both the coil wire and turn off all accessories.
4. Connect the voltmeter positive (+) lead to the alternator output terminal. Connect the voltmeter negative (–) lead to the battery positive (+) post.

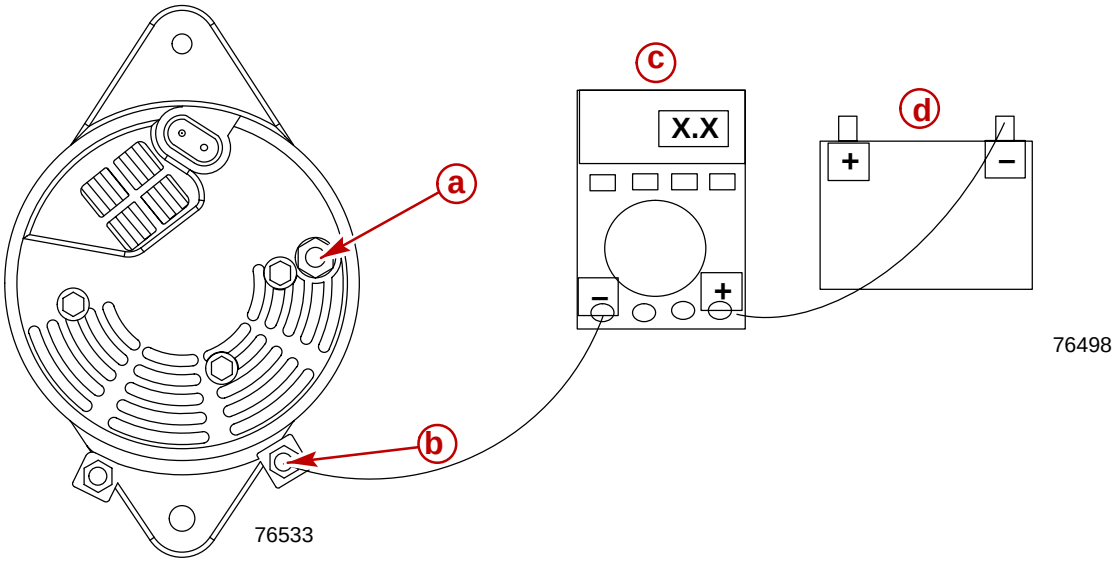
NOTE: *Connect the voltmeter leads to the battery post, NOT the battery cable end.*



Typical

a - Output terminal
b - Ground terminal
c - Voltmeter
d - Battery

5. Start the engine and operate at 1300-1500 rpm. Read the voltmeter. A reading of more than 0.5 volts shows excessive resistance in the wiring.
6. Connect the voltmeter negative (–) lead to the alternator ground terminal. Connect the voltmeter positive (+) lead to the battery negative (–) post.



Typical

a - Output terminal
b - Ground terminal
c - Voltmeter
d - Battery

7. Repeat Step 5.

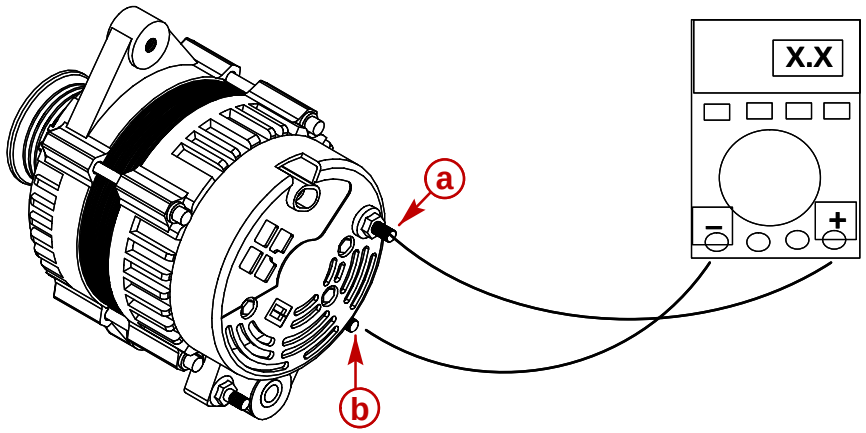
Circuitry

Perform the following tests with a DMT to ensure that all of the circuits between the alternator and the other components within the charging system are in good condition.

1. Connect the DMT positive (+) lead to the battery positive (+) post.
2. Connect the DMT negative (–) lead to the battery negative (–) post.

OUTPUT CIRCUIT

1. Start the engine and increase rpm to approximately 1300 rpm.
2. Observe the voltage reading.
3. If the reading is between 13.5 and 14.2 volts, switch the DMT to the AC volt position. and observe. A reading of 0.25 AC volts or less indicates that the alternator diodes are fully functional. A reading above 0.25 AC volts indicates that the diodes are faulty and the alternator must be replaced.
4. If the reading is below 13.5 volts:
   a. Connect the positive (+) voltmeter lead to the alternator output post.
   b. Connect the negative (–) lead to the ground post on the alternator.
   c. Wiggle the engine wiring harness while observing the voltmeter. The meter should indicate the approximate battery voltage and should not vary. If no reading is obtained, or if the reading varies, refer to Resistance.



78145

a - Output wire - ORANGE
b - Ground

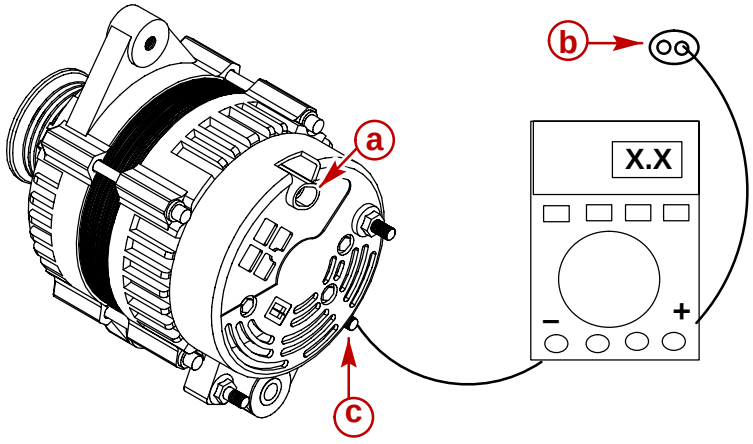
5. If the reading is above 15 volts, the alternator is overcharging and must be replaced.

EXCITATION CIRCUIT

1. Connect the positive (+) voltmeter lead to the tie strap terminal on the alternator and the negative (–) lead to a ground terminal on the alternator.
2. Turn the ignition switch to the ON position and note the voltmeter reading. The reading should be 1.3 to 2.5 volts.
3. If no reading is obtained, an open exists in the alternator excitation lead or in the excitation circuit of the regulator. Unplug the PURPLE lead from the regulator. Connect the positive voltmeter lead to the PURPLE lead and the negative voltmeter leads to the ground. If the voltmeter now indicates the approximate battery voltage, the voltage regulator is defective and must be replaced. If no voltage is indicated, check the excitation circuit for loose or dirty connections or damaged wiring.

SENSING CIRCUIT

1. Unplug the RED and RED/PUR connector from the alternator.
2. Connect the positive (+) voltmeter lead to the RED/PUR pin and the negative (–) voltmeter lead to the ground terminal.
3. The voltmeter should indicate the battery voltage. If battery voltage is not present, check the RED/PUR wire for loose or dirty connection or damaged wiring.



78146

a - Connector location
b - RED and RED/PUR connector
c - Ground

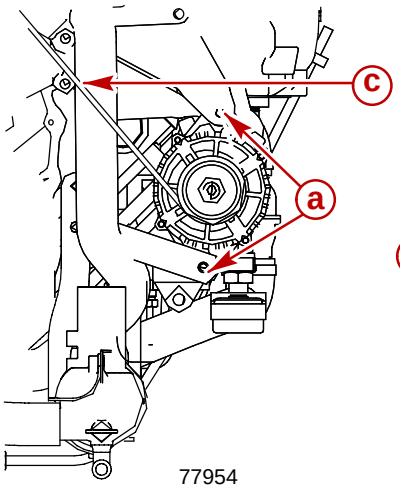
Removal

Alternator

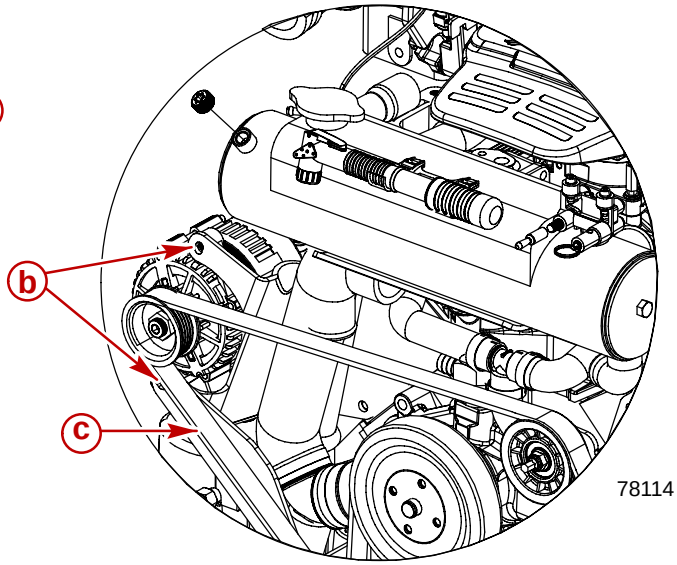
⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables from the battery.
2. Disconnect the lead and ground wires.
3. Disconnect the excitation wire.
4. Remove the drive belt.
5. Remove the alternator mounting bolts and the washers.



77954



78114

a - MIE mounting bracket
b - MCM mounting bracket
c - Serpentine belt

6. Remove the alternator.

Alternator Bracket

1. Drain the cooling system.
2. Remove the water circulating pump hose.
3. Remove the bracket

Installation

Alternator Bracket

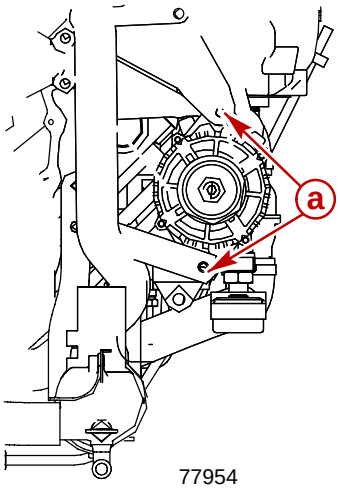
1. Install the alternator bracket. Torque the screws.

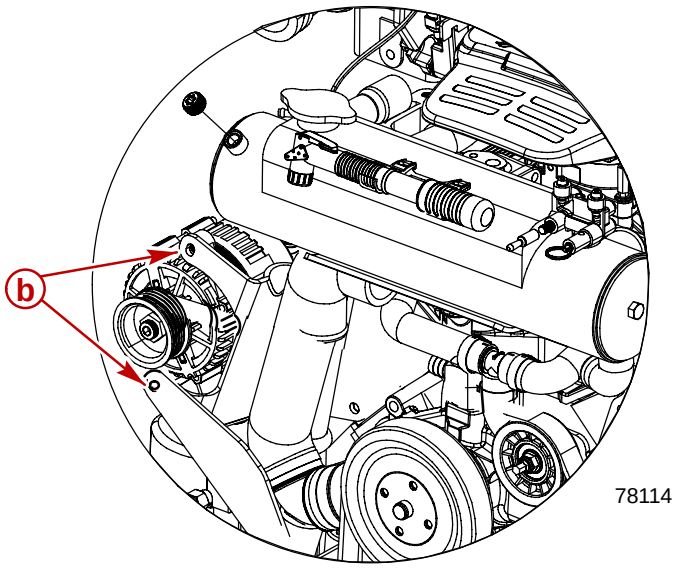
Description	Nm	lb-in.	lb-ft
Alternator mounting bracket screws	41		30

2. Install the water circulating pump hose and securely tighten the hose clamps.

Alternator

1. Install the idler brace.
2. Position the alternator in the mounting bracket.
3. Install the mounting bolts and torque.

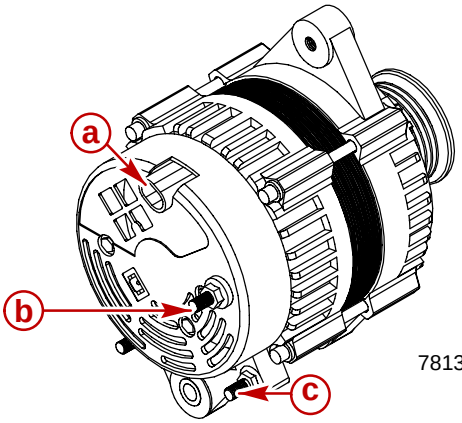




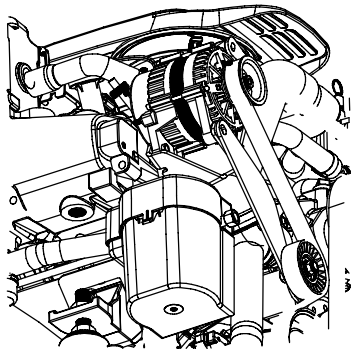
a - MIE mounting bracket
b - MCM mounting bracket

Description		Nm	lb-in.	lb-ft
Alternator mounting bolts	M8 x 1.25	11		8

4. Position the alternator drive belt on the pulleys and adjust the tension.
5. Reconnect the wiring harness to the alternator.



78134


77945

a - RED and RED/PURPLE connector
b - ORG wire
c - Ground

6. Connect the both battery cables to the battery.
7. Fill the cooling system with the specified fluid. Refer to **Section 1B**.

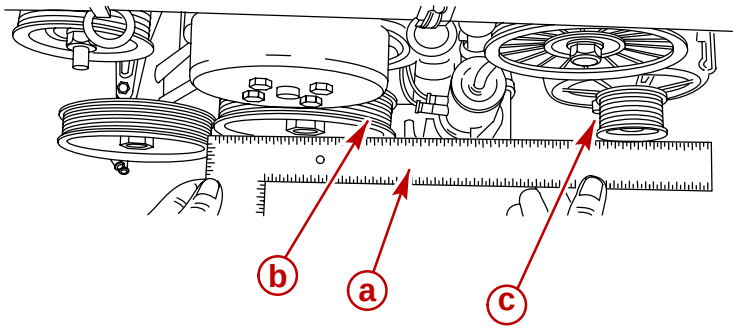
Pulley Alignment

Misaligned pulleys can cause belt shredding. Check the alignment if belt shredding occurs.

ALTERNATOR PULLEY ALIGNMENT

1. Use a sturdy, metal straight edge that is at least 40.7 cm (16 in.) long.
2. Place the straight edge across the crankshaft pulley and then move it up to the alternator pulley. The straight edge should be just under the alternator pulley instead of across the pulley.
3. Compare the angle of the outer face of the alternator pulley to the straight edge. It should be almost parallel. The outer face of the alternator pulley may be slightly in front of or behind the straight edge, but this does not cause a problem.

NOTE: *The alternator pulley does not have to be touching the straight edge, it just has to be parallel to it.*



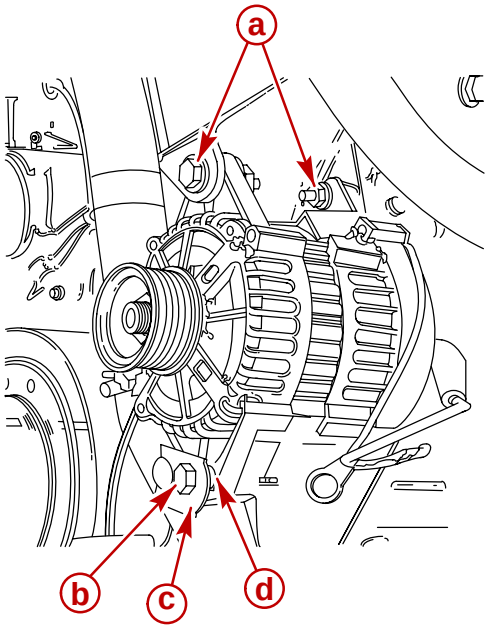
79281

a - Straight edge
b - Crankshaft pulley
c - Alternator pulley parallel to straight edge

NOTE: *Ensure that the 2 upper alternator mounting bolts and nuts are loose enough so that you can move the alternator. The alternator must be able to pivot.*

4. Remove the serpentine belt and loosen the 2 mounting bolts and nuts at the upper alternator mounting bracket.
5. Remove the single M8 bolt from the lower alternator mounting brace.
6. Install the spacer between the lower mount brace and the alternator.
7. Install the M8 bolt through the lower brace, spacer, and alternator. Tighten the M8 bolt, leaving both upper alternator mounting bolts and nuts loose.

8. Torque the M8 bolts.



79283

a - Upper mounting bolts and nuts
b - Lower M8 bolt
c - Lower alternator brace
d - Spacer goes between lower alternator brace and alternator

Description	Nm	lb-in.	lb-ft
M8 bolt	11	96	

9. Recheck the alignment on the alternator pulley with the straight edge.

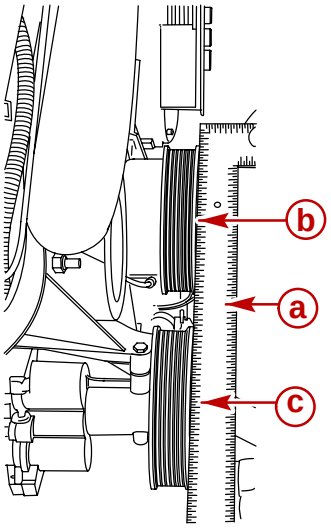
NOTE: *The alternator pulley does not have to be touching the straight edge, it just has to be parallel to it.*

10. If the alternator is parallel, tighten the 2 upper alternator mounting bolts and nuts. Torque the nuts.

Description	Nm	lb-in.	lb-ft
Upper alternator mounting nuts	48		35

SEAWATER PUMP PULLEY ALIGNMENT

1. Place the straight edge across the seawater pump pulley and the crankshaft pulley.
2. Compare the angle of the outer face of the alternator pulley to the straight edge. It should be almost parallel. The outer face of the alternator pulley may be slightly in front of or behind the straight edge, but this does not cause a problem.



79282

a - Straight edge
b - Crankshaft pulley
c - Seawater pump pulley parallel to straight edge

3. The seawater pump pulley must be parallel within 1.5 mm (1/16 in.) of the straight edge. If not, replace the bracket.
4. Install pump to new bracket. Torque the seawater pump fasteners.

Description	Nm	lb-in.	lb-ft
Seawater pump fasteners	9.9	88	

NOTE: *If original seawater pump bracket had washers between it and the engine cylinder block, discard these washers. The new bracket does not use a washer between it and the cylinder block.*

NOTE: *There has been a stiffening tab added to the new bracket. Because of this, the location of the mounting stud and bolt (to the cylinder block) has to be changed when installing this bracket.*

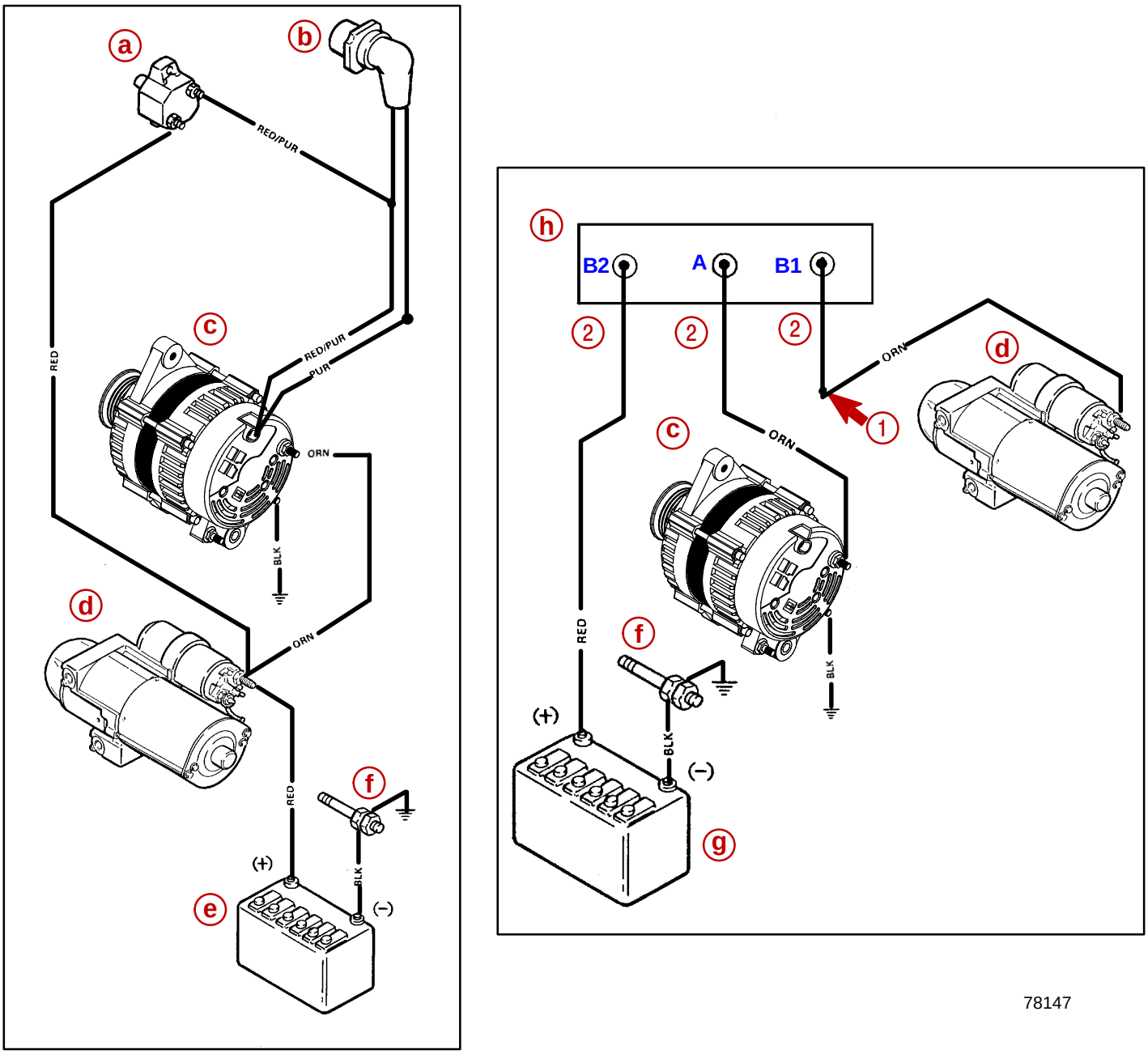
5. Move stud from lower cylinder block hole up to the one that had the bolt in it.
6. Install bracket onto stud then rotate to install the original bolt through the lower bracket hole.
7. Torque the seawater pump bracket fasteners.

Description	Nm	lb-in.	lb-ft
Seawater pump bracket fasteners	41		30

SERPENTINE BELT

1. Install the new serpentine belt and adjust it until there is 13 mm (1/2 in.) deflection between the upper 2 pulleys.

Battery Isolator Diagram



a - Circuit breaker
b - Harness connector
c - Alternator
d - Starter
e - Cranking battery
f - Ground stud
g - Auxiliary battery
h - Isolator

1 - Disconnect ORANGE wire from alternator battery terminal. Splice sufficient gauge wire to the ORANGE wire and connect.
2 - 8 gauge minimum

ELECTRICAL SYSTEM

Section 4E - Instrumentation

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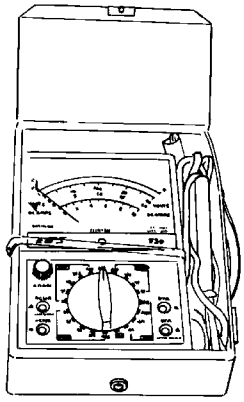
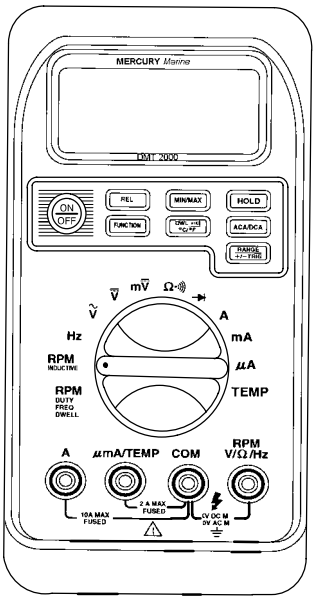
4 E

Tools

Special Tools

DVA / Mult-Meter Kit		
 73609	Tests the electrical and ignition systems; consists of a VOA meter with built-in direct voltage adapter.	91-99750A1

DMT 2000A Tachometer / Multi-Meter Kit		
 77959	Measures rpm on both 2 and 4 cycle marine engines, records the maximums and minimums simultaneously and will read accurately in high RFI environments. Replacement components: 91-854010-1 Inductive Pick-Up 8 ft (2.4 m) 91-854011-1 Temperature Probe 91-854012 Ferrite Core 91-854013-1 Interface Module 91-854014-1 Hard Carrying Case 91-854015-1 User's Guide 91-802651 Test Leads Optional Accessories: 84-854016T 8 ft. (2.4 m) Inductive Pick-Up Extension 91-802650-1 Clamp-On Current Probe 91-89045-1 Direct Voltage Adapter	91-854009A3

Kent-Moore Tools

	Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500
Description	**Part Number**
Connector Test Adapter Kit	J-35616-A

Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Loctite Pipe Sealant with Teflon	Temperature sender threads	Obtain locally
Liquid Neoprene	Electrical terminals	92-25711--3

Wire Color Abbreviations

BLK	Black		PUR or PPL	Purple
BLU	Blue		RED	Red
BRN	Brown		TAN	Tan
GRY	Gray		WHT	White
GRN	Green		YEL	Yellow
ORN	Orange		LIT or LT	Light
PNK	Pink		DRK	Dark

Precautions

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

⚠ WARNING

Switch and sender testing involves the use of intense heat. Failure to follow appropriate procedures or warnings can cause burns which can result in severe personal injury. While performing the following test, observe these general precautions:

- **Wear personal protective clothing such as rubber gloves, a non-flammable apron and eye protection - preferably full face shield or safety glasses.**
- **The appropriate heat source should only be electric. Heat source should be operated by a qualified person. Follow all instructions of the manufacturer of the heat source. The heat source should be checked each time it is used to ensure it is functioning properly.**
- **The thermometer used in the test should be a high- temperature thermometer with a maximum reading of at least 150°C (300°F). Under no circumstances should the operator allow temperatures to exceed test specifications.**
- **Perform test only in a well ventilated area.**
- **Use a suitable container, such as metal, to hold the sand. Avoid use of glass containers unless the operator first confirms for himself/herself that the glass container is an appropriate high-temperature vessel.**
- **Because the components will reach high temperatures Do not handle materials or components until COMPLETELY cooled.**

General Information

IMPORTANT: If all the instruments malfunction, an electrical overload may have occurred. A fuse may be defective or a circuit breaker may be tripped open. The cause must be found and corrected before replacing fuse or resetting the circuit breaker.

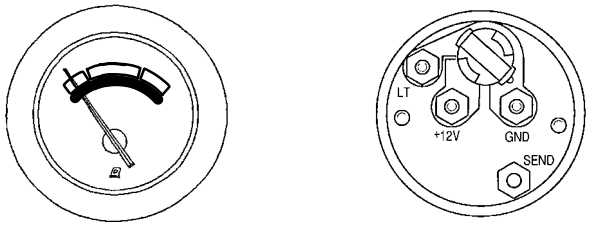
IMPORTANT: If all instruments instruments, check the main harness or electrical connector to ensure a good connection.

Before testing individual instruments, check the following:

- Battery is fully charged.
- Circuit breaker is closed.
- All wires in circuit are connected.
- All connections are tight and corrosion free.
- Connectors are fully engaged.

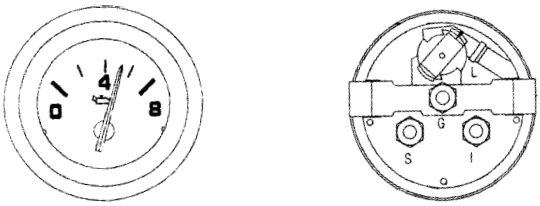
Analog Gauges

Identification



72965

Typical QSI Series



77333

Typical Admiral Series (back of Flagship series similar)

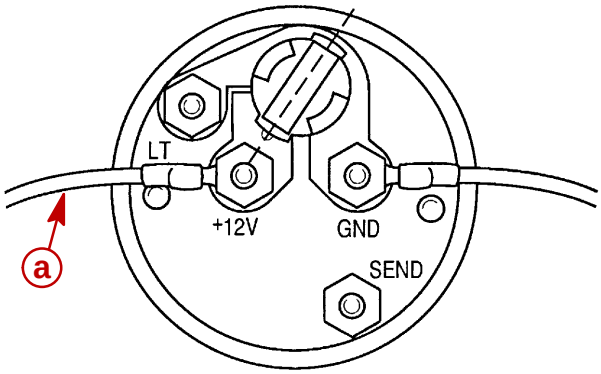
Lighting Options

Some gauges may be wired so that the illumination lighting is provided from the ignition switch or a separate instrumentation lighting switch. By removing contact strip “I” from between + terminal and the screw as shown following, and supplying a separate +12 V power supply to the screw connection, illumination lights can be operated independent of ignition switch.

Other gauges are equipped with optional illumination lighting. Light bulb socket can be removed and contacts can be aligned to be used with ignition switch lighting circuit +12 V or separate instrumentation lighting circuit LT.

IMPORTANT: Light socket must be removed from gauge and turned counterclockwise (facing back of gauge) when adjusting to desired setting. Turning socket while still installed in gauge could result in damage to gauge or socket.

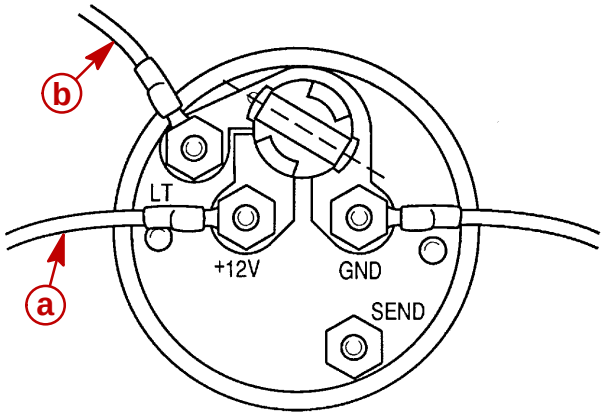
NOTE: *For different lighting effects, colored sleeves are available through the Quicksilver Accessories and can be assembled to the bulb.*



72968

Typical ignition switch lighting circuit position

a - Positive (+) 12 volt power supply from ignition switch



72969

Typical separate instrumentation lighting circuit position

a - Positive (+) 12 volt power supply from ignition
b - Positive (+) 12 volt power supply from separate instrumentation lighting circuit

Circuits

Typical gauges are shown. One terminal is the positive (+), the second terminal is the ground (–) and the third terminal is the light. Some gauges will have a terminal for the sender (S). The information below is how most gauges are marked.

IMPORTANT: Some tachometers may have a dial that has to be set to the type and/or number of cylinders the engine has before it will give the correct engine rpm.

If the gauges have different markings, contact that manufacturer.

1. The positive (+) terminal supplies 12v battery voltage to the gauge. The terminal may be marked with a (+), POS, +12v, B+, IGN or I.
2. The ground (–) terminal is the ground for the gauge. The terminal may be marked with a (–), G. GND, GRD or no mark.
3. The light terminal supplies 12v battery voltage to the gauge's light. This terminal may be marked with a LT, light, I or no mark. This terminal is usually next to the light bulb.
4. The sender terminal receives the signal from the sender on the engine. This terminal may be marked with a S, SND or SEND.

IMPORTANT: When changing a gauge, do not overtighten bracket and distort case.

5. When changing or testing a gauge, coat terminals with Quicksilver Liquid Neoprene to protect them.

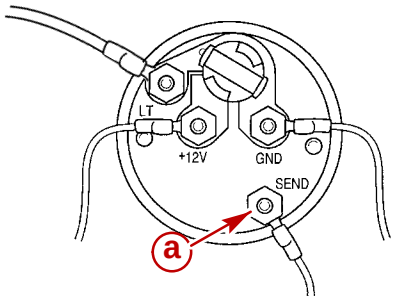
Removal

1. Disconnect battery cables.
2. Remove wires from back of gauge.
3. Disconnect light socket wiring, if separate.
4. Remove holding strap and remove gauge.

Testing

OIL, FUEL, AND WATER TEMPERATURE

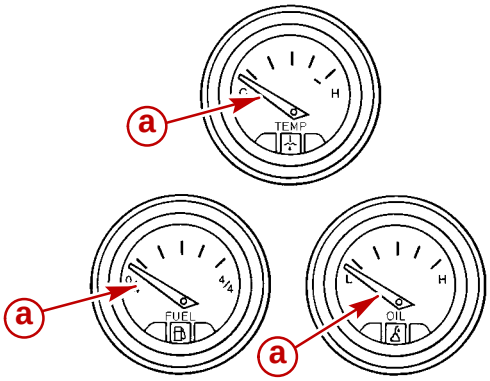
1. Turn ignition switch to the “OFF” position.
2. Remove signal wire from terminal SEND (“S”).



72819

a - Sender wire lead

3. Turn ignition switch to the “RUN” position. Indicator needle on the gauge should be positioned as shown.

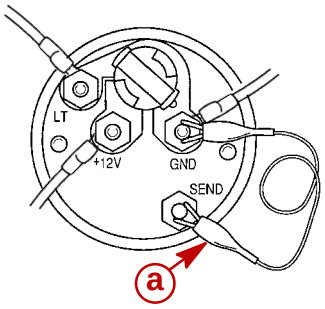


72747

Typical

a - Indicator needle

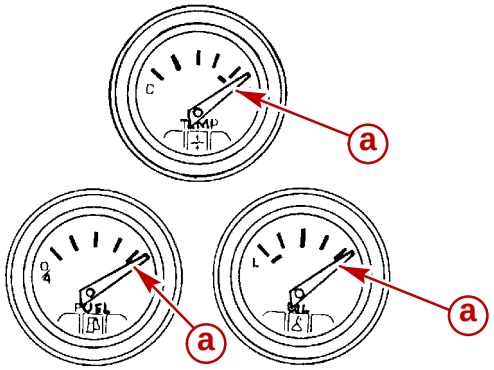
4. Turn ignition switch to the “OFF” position.
5. Connect jumper wire from terminal G (GND) to terminal SEND (“S”).



72748

a - Jumper wire

6. Turn ignition switch to the “RUN” position. Indicator needle on the gauge should be positioned as shown..



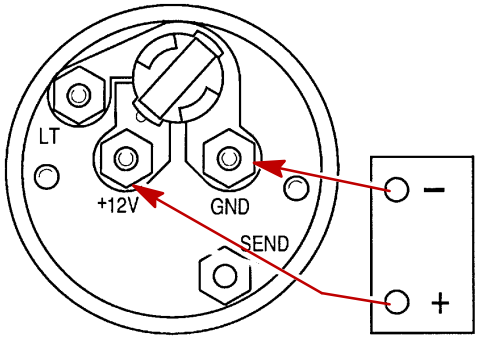
72749

Typical

a - Indicator needle

BATTERY OR VOLTAGE GAUGE

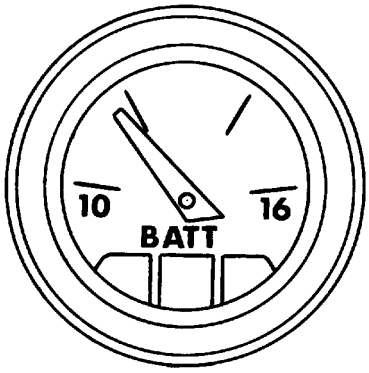
1. Use a fully charged 12v battery. Check voltage with voltmeter.
2. Connect a jumper wire from the positive (+) battery post to the positive (+) gauge terminal.
3. Connect a jumper wire from the negative (–) battery post to the (–) gauge terminal.



72750

Typical

4. Gauge should read approximately the same voltage as a fully charged battery.

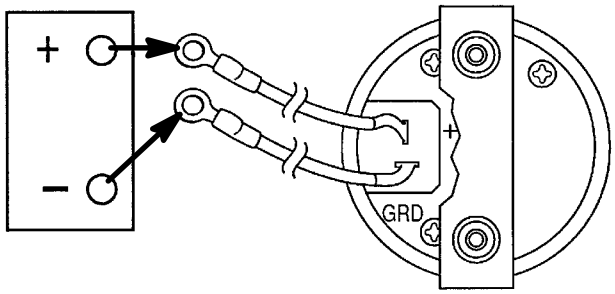


72751

Typical

CRUISELOG (ENGINE HOUR METER)

1. Remove cables from battery and fully charge battery.
2. Remove wires from back of gauge.
3. Connect positive (+) jumper lead from battery to gauge terminal + (12 V).
4. Connect negative (–) jumper lead from battery to gauge terminal “GND” (ground).



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5. Observe gauge run indicator on face of gauge. If indicator is turning, the gauge is operable. If indicator is not turning, replace gauge

TACHOMETER

1. Connect a service tachometer to engine and compare readings between the service tachometer and the original tachometer.
2. Replace if not within specifications.

Tachometer	Allowance
6000 rpm	± 150 rpm

SPEEDOMETER

IMPORTANT: When testing speedometer gauge for accuracy, the air supply used for the test must be regulated to the specified air pressure. Do not apply excessive air pressure to speedometer gauge.

1. Apply air pressure directly to speedometer gauge (specified in chart) and note gauge reading. Lightly tap pressure gauge during accuracy check.
2. If gauge readings are not within specifications, replace gauge.

Air Pressure Gauge psi	Speedometer Gauge MPH (km/Hr)
5.3	20±2 (32±1.6)
27.8	45±1 (72±1.6)

Installation

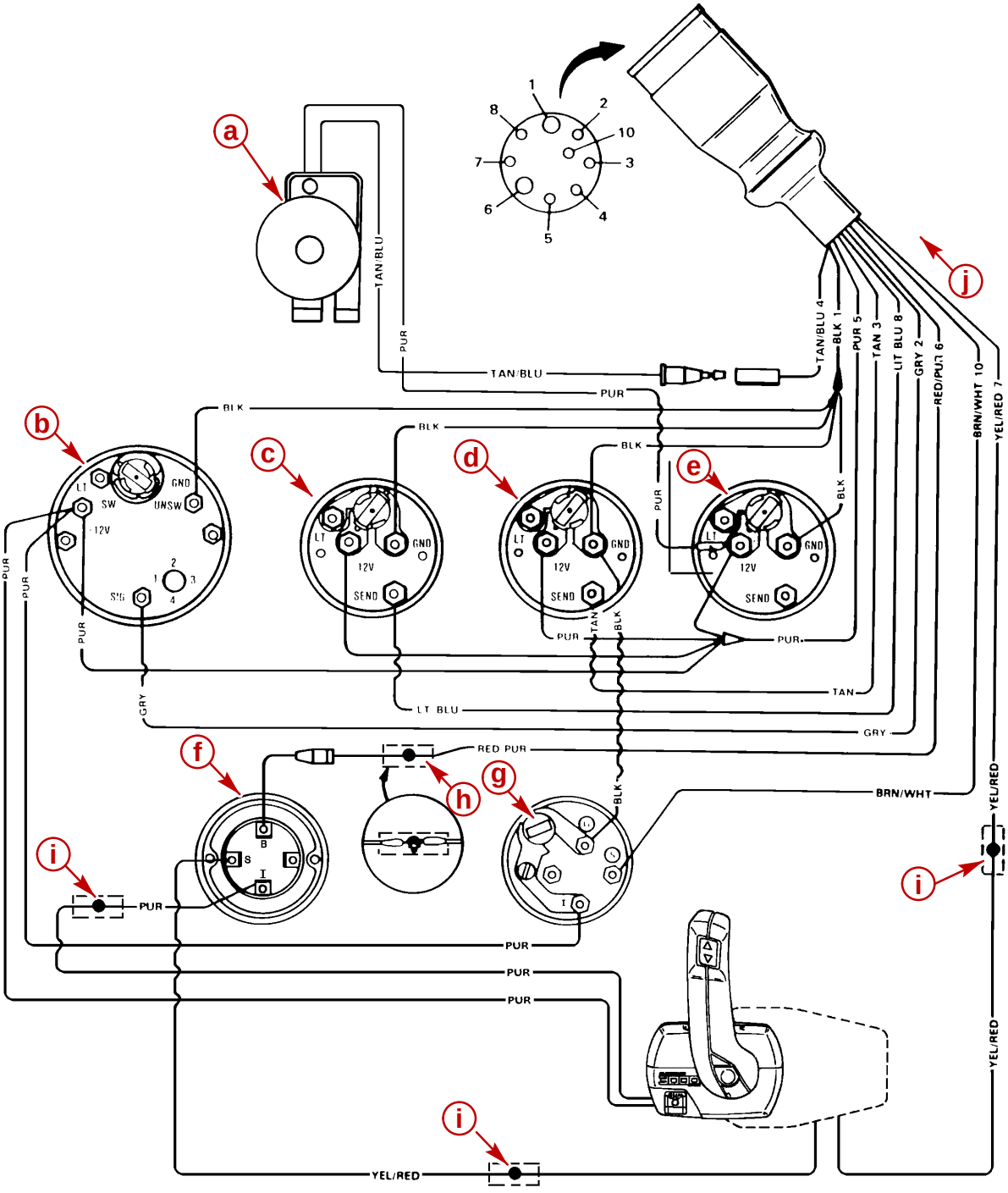
1. Position gauge assembly in appropriate mounting hole.
2. Install holding strap and nuts. Tighten nuts evenly and securely.

IMPORTANT: Do not distort case or bracket by over tightening.

3. Connect ground wire to ground terminal, if gauge is not mounted in metal panel.
4. Connect other wires to gauge as shown in the following diagram.
5. Install gauge light socket.
6. Coat all terminals with liquid neoprene.
7. Reconnect battery cables to battery.

NOTES:

Single Station Installations - Typical



74583

Single Station Installations - Typical

Refer to gauge manufacturer's instructions for specific connections.

***NOTE: 1** Connect Wires Together with Screw and Hex Nut; Apply Liquid Neoprene to Connection and Slide Rubber Sleeve over Connection.*

***NOTE: 2** Power for a Fused Accessory Panel May Be Taken from This Connection. Load Must Not Exceed 40 Amps. Panel Ground Wire Must Be Connected to Instrument Terminal That Has an 8-Gauge Black (Ground) Harness Wire Connected to it.*

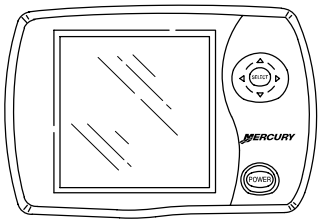
***NOTE: 3** Lanyard stop switch lead and neutral safety switch leads must be soldered and covered with shrink tube for a water proof connection. If an alternate method of connection is made, verify connection is secure and sealed for a water proof connection.*

- **a -** Audio warning alarm
- **b -** Tachometer
- **c -** Oil pressure
- **d -** Water temperature
- **e -** Battery meter
- **f -** Ignition switch
- **g -** Trim indicator
- **h -** Read/Observe NOTE 1 and 2.
- **i -** Read/Observe NOTE 3.
- **j -** To engine wiring harness

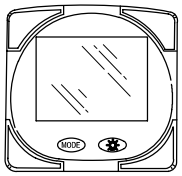
Digital Gauges

These digital gauges are available for use on any Mercury MerCruiser engine equipped with a ECM 555 controller.

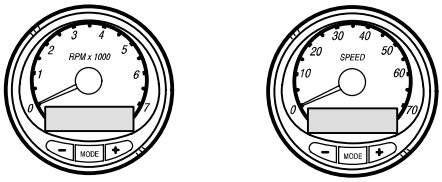
Identification



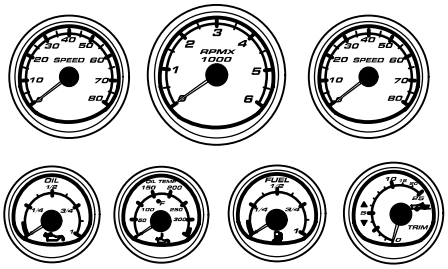
System View (SC5000)



System Monitor



System Tachometer and Speedometer



System Link Gauges

These digital gauges are available for use on any Mercury MerCruiser engine equipped with a ECM 555 controller.

Features

Basic Features	System Tach	System Speed	System Monitor	System View
Light Brightness	*	*	*	*
Light Contrast Adjustment	*	*		*
Engine Alarm Displays	*		*	*
Troll Control	*	*		cruise
Smart Link Accessory Gauge Connection	*		*	*
Interchangeable Bezels	*	*	*	*
GPS Connection		*		*
Engine Sync Display		*		*
Preventive Maintenance Schedule				*

Displays

Basic Displays	System Tach	System Speed	System Monitor	System View
Digital Tachometer	*		*	*
Digital Speedometer		*		*
Engine Hour Meter	*		*	*
Power Trim Angle	*		*	*
Fuel Flow	*		*	*
Engine Temperature	*		*	*
Battery Voltage	*		*	*
Engine Coolant Pressure	*		*	*
Clock		*		*
Outside Air Temperature		*		*
Lake Water Temperature		*		*
Fuel Tank Level		*	alarm	*
Oil Tank Level		*		*
Fuel Economy		*		*
Fuel Range		*	*	*
Trip Log		*		*
Fresh Water				*
Waste Water				*
Water Depth	*		*	*
Oil Temperature	*		*	*
Oil Pressure	*		*	*
Fuel Used	*		*	*
COG/SOG		*		*
FTW		*		*

Troubleshooting

SYSTEM MONITOR

DESCRIPTION	SOLUTION
Gauge is showing moving rpm and data but engine has not yet been started	Monitor is in simulator mode.
Won't drive Link Gauges	Make sure the end of the M2 harness that has the link connector is connected to the gauge not the J-box.
How do I check a Blue cable to make sure it is ok?	Blue and White are your communication wires. Ohm across those 2 wires. You should get 60 ohms with two terminators installed and 120 ohms with only one installed.
Can I hook up an analog fuel gauge as well as a SmartCraft fuel gauge?	No. This will cause a ground loop through the 5 volt transducer bus and could damage the ECM.
Is there any special wiring need for dual engine applications?	On one of the engines you need to disconnect the 3 pin connector attached to the 10 pin, so that the engines will not back feed 12 volts to each other.
How do I check pinout on a 10 pin CAN connector	A = RED B = BLK C = YEL (gauge end only) D = BLU E = WHT F = PUR
When powering down Engine and Bell icon will display for several seconds	Engine still in break-in or audio alarm is disabled.
Fuel and Bell icon displays with no audio warning	Calibrate the gauge to read zero fuel capacity.
Erratic readings on all gauges	On dual engine applications using single CAN line one engine must have the three wire harness disconnected.

SYSTEM VIEW

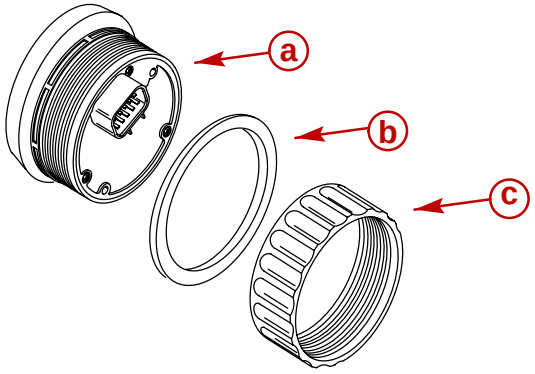
DESCRIPTION	SOLUTION
Fuel tank shows full all of the time	Performed add fuel calibration on an empty tank and never added the fuel.
Unit is not saving calibrations	You must key off until screen goes blank or data may not save.
How do I check a Blue cable to make sure it is ok?	Blue and White are your communication wires. Ohm across those 2 wires. You should get 60 ohms with two terminators installed and 120 ohms with only one installed.
Can I use a Blue cable with System View or only Yellow?	If you are using System View in a non-Drive by Wire application you can use Blue. When Drive by Wire is involved you must use Yellow.
Can I hook up an analog fuel gauge as well as a SmartCraft fuel gauge?	No. This will cause a ground loop through the 5 volt transducer bus and could damage the ECM.
Is there any special wiring need for dual engine applications?	On one of the engines you need to disconnect the 3 pin connector attached to the 10 pin, so that the engines will not back feed 12 volts to each other.
How do I check pinout on a 10 pin CAN connector	A=Red B=Black C=Yellow (gauge end only) D=Blue E=White F=Purple

SYSTEM TACH/SPEED

Description	Solution
Screen says “data bus error”	Are there 2 terminators connected? - ECM not communicating, check Blue and White wire in Data Harness
How do I wire my Speed transducer 4 pin plug?	A = BLK B = BLU C = YEL D = WHT
What colors are on the MerCruiser side for depth?	A = BLK B = WHT/BLK C = WHT/PUR D=RED
How do I wire my Depth transducer 4 pin plug?	A = BLK B = BLU C = WHT D = RED
How do I perform a Master Reset?	Hold both Troll – and Troll + until the two bars on the graphic display collide.
Won’t drive Link Gauges	Make sure the end of the tach harness that has the link connector is connected to the gauge not the J-box.
GPS does not work	Make sure the end of the tach harness that has the link connector is connected to the gauge not the J-box.
GPS data is intermittent	Switch to NMEA 0183 v1.5 or turn off GSV sentence (Contact GPS manufacturer)
Speed jumps all over	GPS speed is turned on but no GPS is connected.
My data cable is Black the book states it should be Blue	We did manufacture a small amount of Black cables. These cables were recalled. Please return the cable.
How do I check a Blue cable to make sure it is ok?	Blue and White are your communication wires. Ohm across those 2 wires. You should get 60 ohms with two terminators installed and 120 ohms with only one installed.
Can I use a System Speedometer by itself? Can I use SC1000 gauges by themselves?	No. You will need a System Tachometer or System Monitor to run a System Speedometer/Links.
Can I hook up an analog fuel gauge as well as a SmartCraft fuel gauge?	No. This will cause a ground loop through the 5 volt transducer bus and could damage the ECM. Switch to WEMA 2 output Fuel Sender.
Is there any special wiring need for dual engine applications?	On one of the engines you need to disconnect the 3 pin connector attached to the 10 pin, so that the engines will not back feed 12 volts to each other.
After a Master Reset one of the Tachometers is saying no starboard engine	First make sure both engines are configured properly. Second unplug any Link Gauges connected to that Tachometer. The Link Gauges can freeze temporarily on a Master Reset.
How do I check pinout on a 10 pin CAN connector?	A = RED B = BLK C = YEL (gauge end only) D = BLU E = WHT F = PUR
Gauge says “Multiple Starboard Engine”	Both engine ECM’s are set to starboard. You need to make one port with a DDT or Rinda tool.
Gauge says “No Starboard Engine”	Engines are set to port. At least one engine must be set to starboard for the gauge to work. Set one engine to starboard.
No Tach Display on Speedometer	Tachometer needs to be programmed before Speedometer.
How is the fuel burned zeroed out?	Depress Mode and Troll - on Speedometer

Removal

1. Disconnect both battery cables from the battery.
2. Disconnect the CAN line connector from the back of the gauge.
3. Remove the retainer nut and seal from the gauge.



a - Gauge
b - Seal
c - Retainer nut

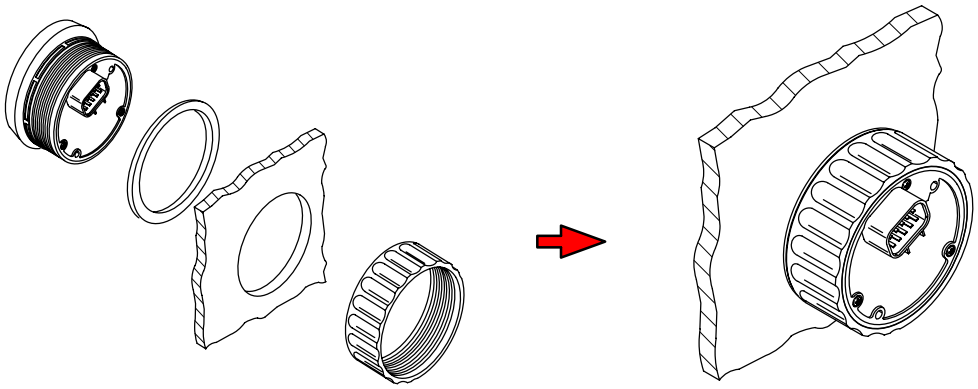
4. Remove the gauge from the dash.

Cleaning And Inspection

1. Inspect the CAN line connections for corrosion and loose fit.
2. Inspect the pins of the connector, ensure that the pins are straight.
3. Inspect the sealing ring for wear and damage.
4. Clean all of the components with a clean, soft, non-abrasive towel.

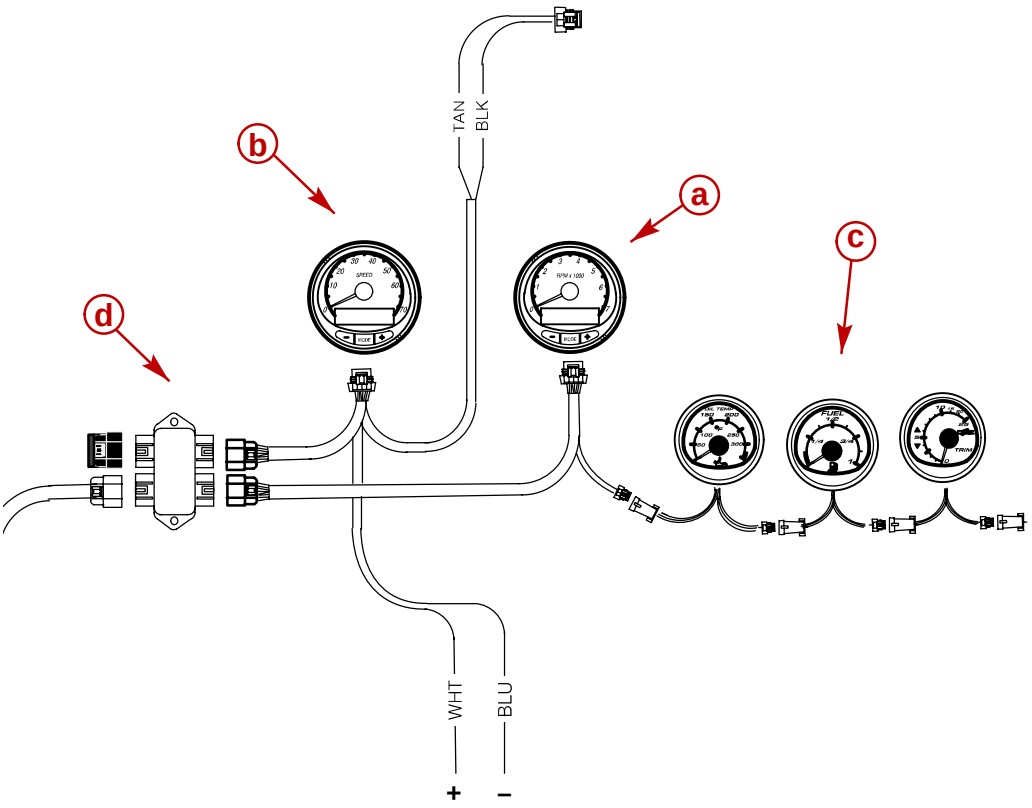
Installation

1. Install the seal onto the gauge.
2. Place the gauge into the dashboard and secure with the retainer nut.



3. Connect the CAN line to the gauge.

Typical System Gauge Installation



a - System tachometer
b - System speedometer
c - System link gauges
d - Junction box

Senders

Oil Pressure

TESTING

IMPORTANT: Use following test procedure for checking accuracy of oil pressure sender only. If oil pressure gauge indicates zero oil pressure, refer to SECTION 1C - "Troubleshooting."

1. Remove wire from sender terminal.
2. Connect ohmmeter between sender terminal and sender case. Check ohms reading without engine running (zero pressure), then check reading with engine running. Compare oil pressure and ohms readings as shown in following chart:

Oil Pressure (psi)	Ohms Reading	
	Single	Dual
0	227-257	114-128
20 (138 kPa)	142-162	71-81
40 (276 kPa)	92-113	46-56
80 (414 kPa)	9-49	5-24

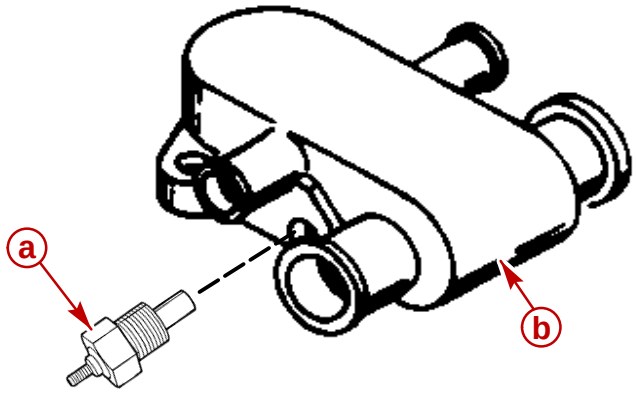
Water Temperature

REMOVAL

1. Drain coolant from closed cooling system into a suitable container.
2. Remove TAN wire from temperature sender.

NOTE: *Hoses are shown removed for clarity.*

3. Remove temperature sender.

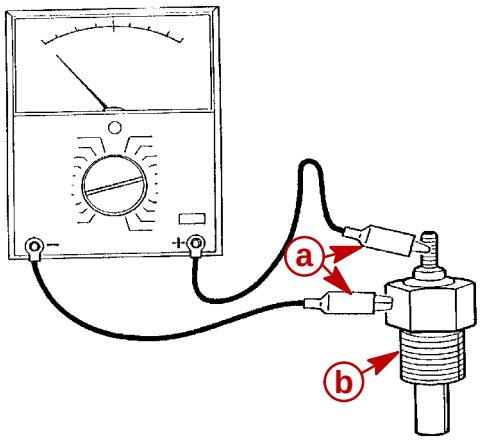


Typical thermostat housing

a - Water temperature sender
b - Thermostat housing

TESTING

1. Connect an ohmmeter between temperature sender terminal (+) and hex for ground (–).



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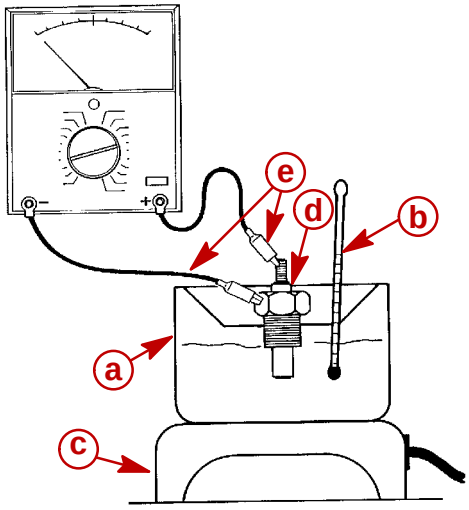
a - Ohmmeter leads
b - Water temperature sender

2. With ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in water.



72769

a - Suitable container
b - Thermometer
c - Heat source
d - Water temperature
e - Ohmmeter leads

3. Heat water and observe thermometer.
4. As temperature rises ohmmeter readings must be within the ranges specified for each temperature.

Water Temperature	Ohms Reading
60 degrees C (140 degrees F)	121 - 147
90 degrees C (194 degrees F)	47 - 55
100 degrees C (212 degrees F)	36 - 41

5. Turn heat source off. Allow water and components to cool.

INSTALLATION

1. Apply sealant to the threads of the temperature sender.

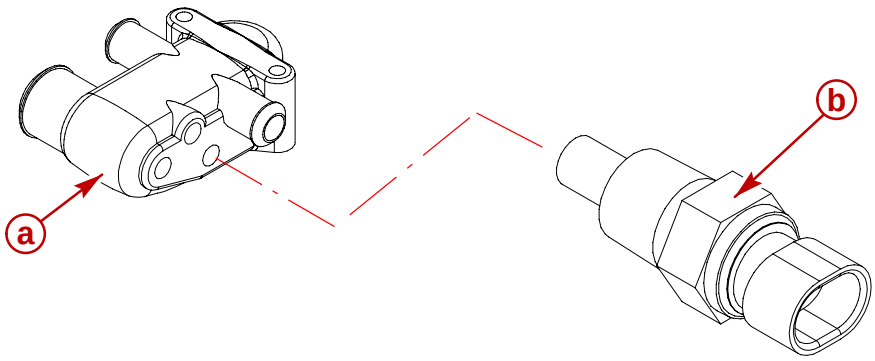
Description	Where Used	Part Number
Loctite Pipe Sealant with Teflon	Temperature sender threads	Obtain locally

2. Install sender in thermostat housing and tighten securely.
3. Connect tan wire and coat with sealant.

Description	Where Used	Part Number
Liquid Neoprene	Electrical terminals	92-25711--3

4. Refill closed cooling system with approved coolant.

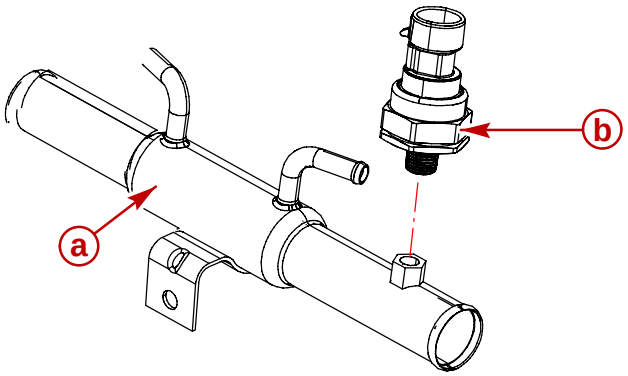
Sensors



77816

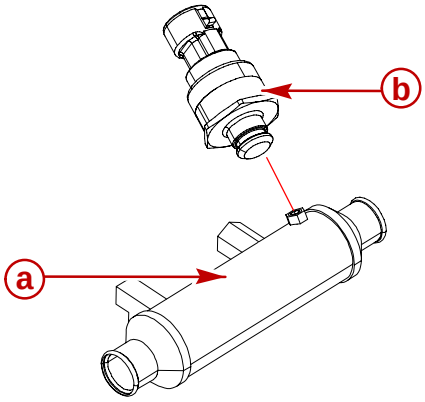
Typical thermostat housing

a - Thermostat housing
b - Coolant temperature sensor (CTS) MPI models



79378

a - Power steering cooler
b - Water pressure sensor



79378

a - Transmission cooler
b - Water pressure sensor

Switches

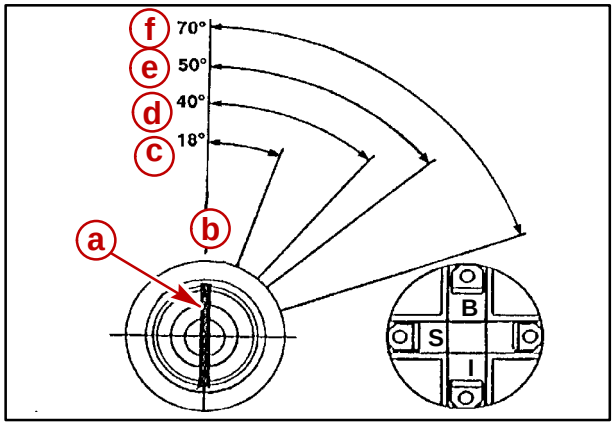
Ignition Key Switch

TESTING

⚠ CAUTION

Disconnect battery cables from battery before testing ignition key switch with wires still connected to switch.

1. Disconnect battery cables, if testing ignition key switch with wires connected to switch.
2. With key switch in OFF position, there should be no continuity between switch terminals.
3. With key switch in RUN position, continuity will exist between switch terminals B to I. There should no continuity between terminal S and any other terminals.
4. With key switch in START, continuity will exist between terminals B to I and B to S.
5. Terminals are to make contact at angles shown and to stay in contact condition as switch is rotated toward START.
6. If ignition key switch tests bad, disconnect wire connections and remove switch. Test switch again. If switch tests good, wiring in harness is bad. There should be no continuity between any harness wires with key switch removed.



72760

Key View **Back View**

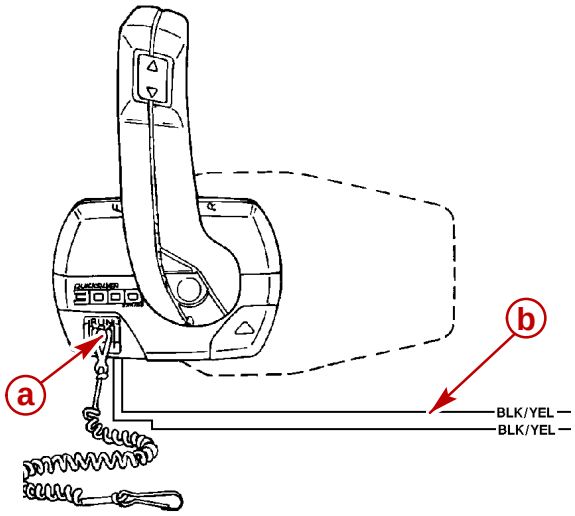
a - Key
b - Off
c - Continuity, B to I terminals
d - Run
e - Continuity B to S terminals
f - Start

7. Replace sender if ohmmeter readings are other than as shown for each temperature.

Lanyard Stop Switches

TESTING

1. Disconnect switch leads.
2. Connect an ohmmeter to leads.
3. There should be continuity with switch lanyard connected and no continuity with switch lanyard disconnected.



74061

Remote control mounted switch

a - Switch lanyard
b - Leads

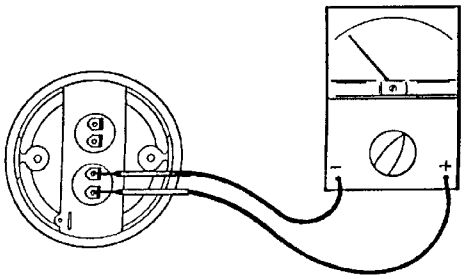
Start/Stop Switch

TESTING

WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables from the battery.
2. Check for continuity between the terminals on the start switch with a continuity meter.



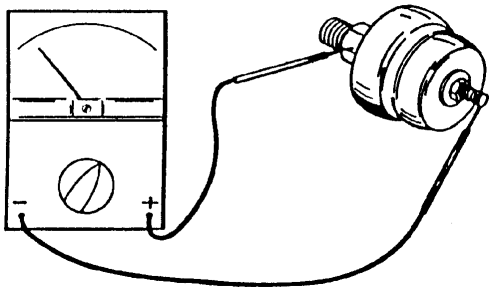
72763

3. No continuity should exist.
4. Depress switch button and continuity should exist.
5. Check stop switch in the same manner.
6. If continuity exists when in the OPEN (not depressed) state, replace panel button.

Oil Pressure Switch

TESTING

1. Remove wire from sender terminal.
2. Connect continuity meter between sender terminal and sender hex. (Sender shown removed for clarity.)



72764

3. With engine not running, meter should indicate full continuity.
4. With engine running and engine oil pressure above 6 psi (41 kPa), meter should indicate no continuity.

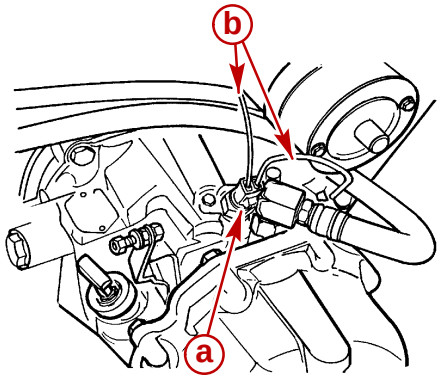
Transmission Fluid Temperature Switch

Switch is located on transmission. Switch is normally open. This switch is used on MIE engines (if equipped).

87-88031 Switch	
Opens	180-200° F (82-93° C)
Closes	220-240° F (104-116° C)

REMOVAL

1. Disconnect harness wires at switch.
2. Remove switch and sealing washer.



72845

Typical location

a - Transmission fluid temperature switch with sealing washer
b - Harness wires

TESTING

⚠ WARNING

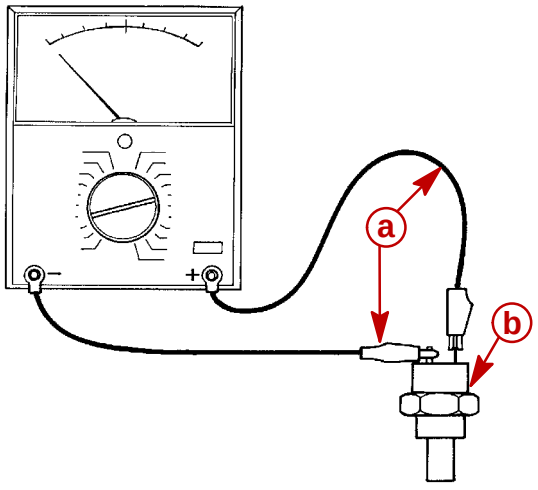
The following test involves the use of intense heat. Failure to follow appropriate procedures or warnings can cause burns can result in severe personal injury. While performing the following test, observe these precautions:

- **Wear personal protective clothing such as rubber gloves, a non-flammable apron, and eye protection - preferably full face shield or safety glasses.**
- **The appropriate heat source should be electric. Heat source should be operated by a qualified person. Be sure to follow all instructions of the manufacturer of the heat source. The heat source should be checked each time it is used to be sure it is functioning properly.**
- **The thermometer used in the test should be a high-temperature thermometer with a maximum reading of at least 300°F (150°C). Under no circumstances should the operator allow temperatures to exceed test specifications.**
- **Perform test only in a well ventilated area.**
- **Use a suitable container, such as metal, to hold the sand. Avoid use of glass containers unless the operator first confirms for himself/herself that the glass container is an appropriate high-temperature vessel.**
- **Because the components will reach high temperatures DO NOT handle materials or components until COMPLETELY cooled.**

⚠ WARNING

Use only clean, dry sand such as used for general sandblasting purposes. Use of sand containing contaminants could result in hazards such as fire, short circuiting, hot-spots or other hazards.

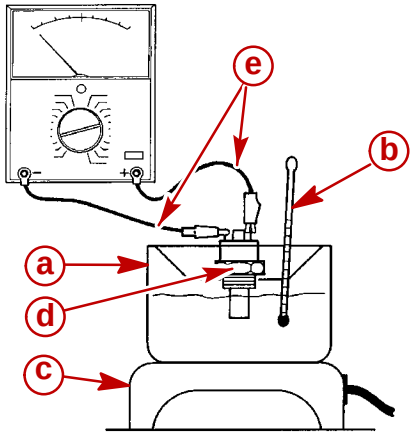
1. Connect one lead of an ohmmeter to one terminal of transmission switch. Connect the other lead of ohmmeter to other terminal.



72771

a - Ohmmeter leads
b - Transmission fluid temperature switch

2. Switches should read no continuity. If continuity exists, replace the switch.
3. With an ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in sand.
4. Heat sand and observe thermometer and ohmmeter.



72772

a - Suitable container
b - Thermometer
c - Heat source
d - Switch or sensor
e - Ohmmeter leads

5. As temperature rises, switch will close and ohmmeter will indicate continuity. Refer to chart below for specifications.

Description	Opens	Closes
48952 Switch	66-77 degrees C (150-170 degrees F)	88-93 degrees C (190-200 degrees F)
87-86080 Switch	79-91 degrees C (175-195 degrees F)	102-107 degrees C (215-225 degrees F)
87-88031 Switch	82-93 degrees C (180-200 degrees F)	104-116 degrees C (220-240 degrees F)

Engine Coolant Temperature (ECT) Sensor		
Temperature - to - Resistance Values (Approximate)		
Degrees F	Degrees C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

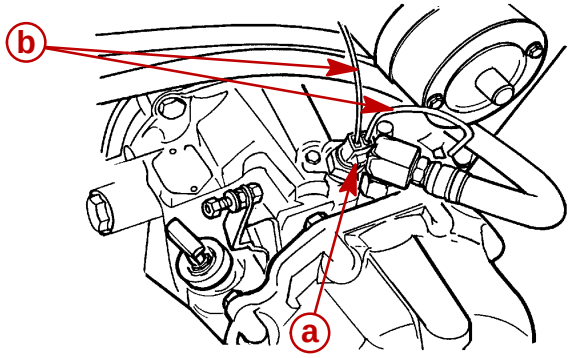
6. Turn heat source off. Allow sand to cool. Note readings again to ensure switch or sensor operates at specified temperature.
7. Replace switch if switch fails within the specified temperature.

INSTALLATION

1. Apply Loctite Pipe Sealant with Teflon to threads of transmission fluid temperature switch.

Description	Where Used	Part Number
Loctite Pipe Sealant with Teflon	Temperature switch threads	Obtain locally

2. Install switch with sealing washer in transmission and tighten securely.



72845

Transmission fluid temperature switch typical location

a - Switch with sealing washer
b - Harness wires

3. Reconnect harness wires and coat with sealant.

Description	Where Used	Part Number
Liquid Neoprene	Electrical terminals	92-25711--3

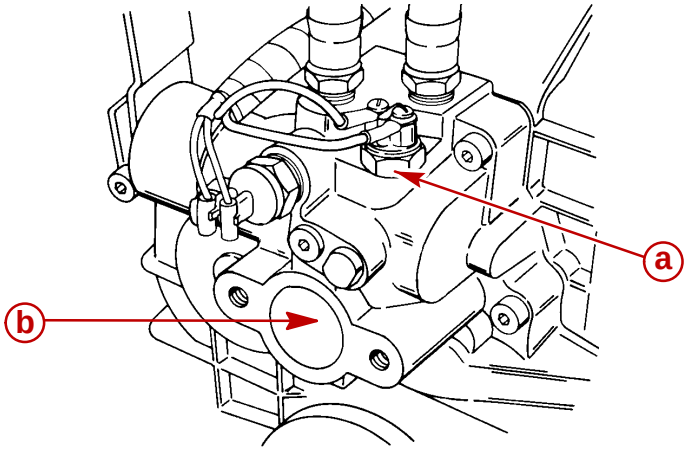
4. Check transmission fluid level.

Sterndrive Gear Lube Monitor Switch

The gear lube monitor is normally open (no continuity between wires) when the gear lube is at the correct level. When the gear lube is low, switch will close causing continuity between wires and alarm will sound.

If alarm is sounding, test to verify if switch is defective by disconnecting wires from the harness. If alarm stops, switch is suspect.

Neutral Safety Switch



50686

a - Neutral safety switch
b - Transmission

FUEL SYSTEM

Section 5A - Carbureted Fuel System

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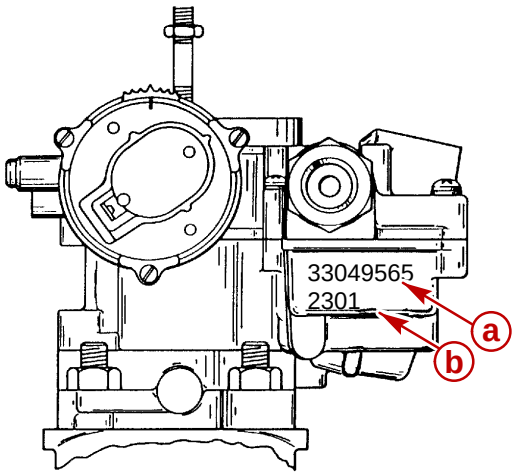
5 A

Identification

Carburetor



72680

2 barrel MerCarb carburetor

a - Part number
b - Date code

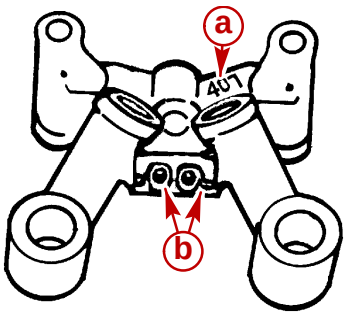
Date Code Explanation: Example 2301

First Figure is Year: 2 = 2002, 3 = 2003, and so on.

Second Figure is Month: 2 = February, 3 = March, and so on to 9 = September, X = October, Y = November, Z = December

Third and Fourth Figures are Day of Month: 01 = First day, 02 = Second day, and so on.

Venturi Cluster



72779

Venturi cluster identification

a - Identification number (see specifications)
b - Accelerator pump discharge holes

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on Mercury MerCruiser Engines and Sterndrives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition, or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition, and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Specifications

Engine Model	5.0L	5.7L
Carburetor type	MerCarb 43 mm	
Standard carburetor part number	3310-861448	3310-861245
Sealed carburetor part number	3310-864942A01[1]	3310-864943A01[2]
Float level	9 mm (11/32 in.)[3,4]	
Float drop	24 mm (15/16 in.)[3,4]	
Pump rod (location)	Middle Hole Of Pump Arm	
Distance between flame arrestor mounting surface and top of pump rod	29 mm (1-5/32 in.)	
Choke setting	2 Marks Right Of Index Mark (Lean)	
Choke unloader	.080 [5/64 in.][3,4]	
Idle mixture screw	1-1/2 Turns Out	
Float weight	9 Grams Maximum	
Main jet size	1.65 mm	
Power valve size	0.90 mm	
Venturi cluster I.D. number	476	475
Accelerator pump discharge hole size	0.889 (0.035)	1.09 (0.043)

[1] *5.0L: P/N 3310–864942A01 with sealed idle mixture screw: Screw set at 1–1/2 turns out.*

[2] *5.7L: P/N 3310–864943A01 with sealed idle mixture screw: Screw set at 1–1/2 turns out.*

[3] *Measurement taken from gasket.*

[4] *All measurements are +/– 0.4 mm (1/64 in.)*

High Altitude Re-Jetting

Engine flooding problems, at idle rpm, are generally related to the altitude (above sea level) at which they are operated. If engine is running too rich at higher elevation, order a smaller jet from the chart. A jet stamped “165” is a 1.65 mm jet.

Model	Carburetor Part Number	1525 m (5000 ft) and Below	1525-2745 m (5000-9000 ft)	2745 m (9000 ft) and Above
5.0L	1389–9563A	1.70 mm	1.60 mm	1.55 mm
	3310-806081A			
	3310–861080			
	1389–9670A	1.85 mm	1.75 mm	1.65 mm
	3310–806082A	1.65 mm	1.50 mm	1.45 mm
	3310-861448A			
	3310-861245A	0.90 mm[1]	0.90 mm	0.74 mm
5.7L	3310-807312A	1.65 mm	1.50 mm	1.45 mm
	3310-861245A	0.90 mm[1]	0.90 mm	0.74 mm

[1] *Power valve jet*

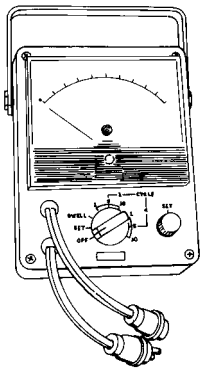
JET SIZES

Jet Size	Quicksilver Part Number
1.30	3302-811849
1.35	3302-811850
1.40	3302-811851
1.45	3302-9050
1.50	3302-811852
1.55	3302-811853
1.60	3302-810923
1.65	3302-9058
1.70	3302-9055
1.75	3302-881854
1.80	3302-811855
1.85	3302-811856
1.90	3302-811857

POWER VALVES

Jet Size	Quicksilver Part Number
0.74	3302–9435
0.90	3302–9059

Special Tools

Tachometer / Dwell-Meter		
 73676	Checks the engine rpm (0-10,000). Also, checks the dwell on breaker point ignition systems.	91-59339

Tools

Description	Part Number
Universal carburetor gauge	91-36392
Float gram scale	Obtain Locally

Precautions

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

⚠ WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Ensure that ignition key is OFF. Do not smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠ WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Ensure that ignition key is OFF. Do not smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

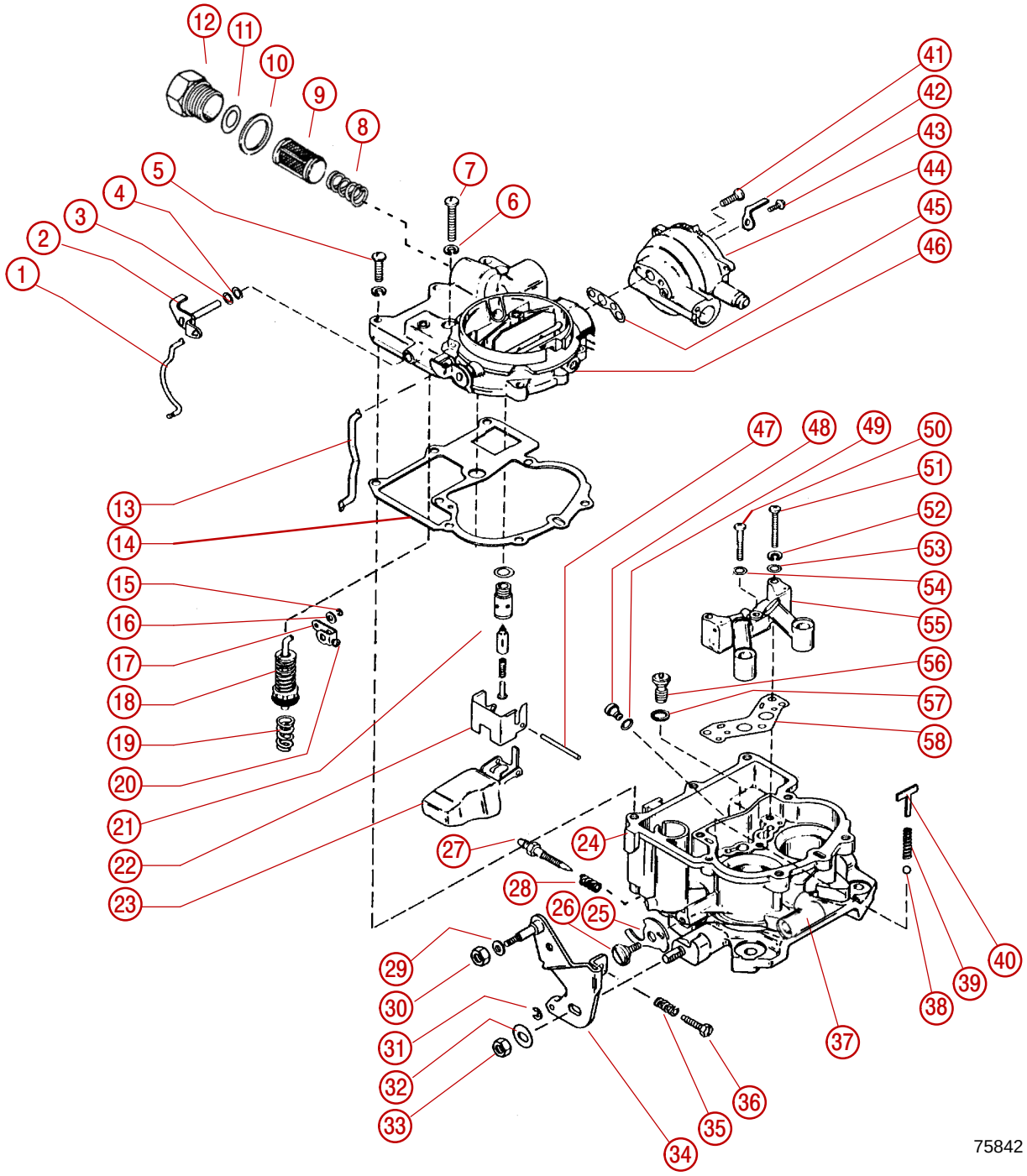
Avoid injury or death and power package damage from a fire or explosion. Make sure no fuel leaks exist before closing engine hatch.

⚠ CAUTION

Do not operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

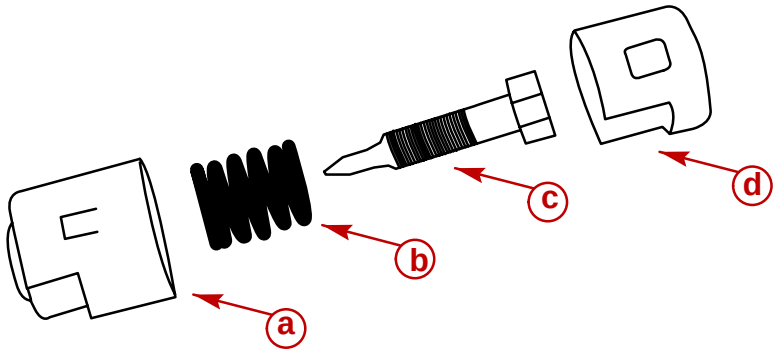
Exploded View

Carburetor



1 - Rod - accelerator pump
2 - Accelerator pump shaft and lever assembly
3 - Washer (outer)
4 - Washer (inner)
5 - Screw
6 - Washer
7 - Screw
8 - Spring
9 - Filter
10 - Gasket
11 - Gasket
12 - Nut-fuel inlet
13 - Choke rod
14 - Gasket
15 - Clip - retainer
16 - Washer
17 - Pump shaft and lever assembly
18 - Accelerator pump assembly
19 - Spring
20 - Screw
21 - Inlet needle and seat (spring loaded)
22 - Baffle plate
23 - Float
24 - Carburetor body
25 - Cam-idle
26 - Screw
27 - Idle mixture adjusting screw
28 - Spring
29 - Washer
30 - Nut
31 - Clip-pump rod
32 - Washer-locking
33 - Nut
34 - Throttle lever
35 - Spring
36 - Screw - idle speed adjustment
37 - PCV tube connection fitting
38 - Check ball
39 - Spring
40 - Retainer
41 - Screw
42 - Lever assembly
43 - Screw
44 - Choke/housing
45 - Gasket
46 - Air Horn
47 - Pin
48 - Screw
49 - Gasket
50 - Screw
51 - Screw
52 - Lockwasher
53 - Flat Washer
54 - Gasket
55 - Venturi cluster
56 - Power valve assembly
57 - Gasket
58 - Gasket

Sealed Idle Mixture Screw



79384

a - Seal cup
b - Spring
c - Idle mixture screw
d - Plug

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb-in.	lb-ft
Carburetor to manifold nuts	27		20
Fuel line to carburetor	24		18
Fuel inlet filter nut	24		18

Description

This MerCarb carburetor is a two bore carburetor that has a separate fuel feed for each venturi. This model is equipped with an electric choke. A removable venturi cluster (secured to float bowl assembly) has the calibrated main well tubes and pump jets built into it. The venturi cluster is serviced as a unit. The serviceable main metering jets are bleeds to properly meter the correct fuel / air mixture to the engine.

Sealed Carburetor Information

NOTE: *The seal can be removed if the replacement carburetor is for an engine boxed at the factory before January 1, 2003.*

All MerCruiser engines (500 hp and below) with a production date of January 1, 2003, or later will be factory-certified to meet the California Air Resources Board (CARB) 2003 exhaust emission standards. Each factory-ertified engine will include a Consumer Information Hang Tag and two California three-star labels, one on the engine and one with instructions for proper installation by the boat builder on MerCruiser-powered boats. The star label is required by the State of California to be affixed to the hull per their guidelines.

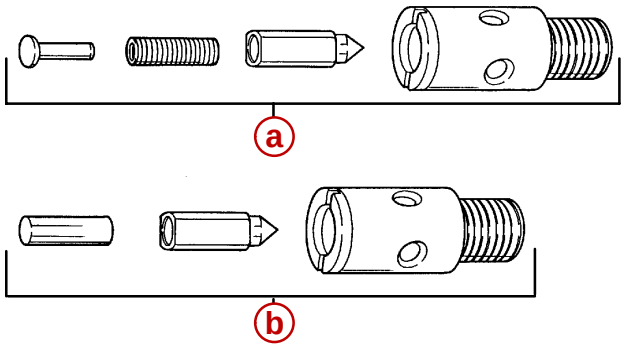
All carburetors on 5.0L and 5.7L engines boxed after January 1, 2003 have a sealed idle mixture screw. The idle mixture screw adjustment is strictly regulated by CARB. However, if the carburetor is overhauled, CARB allows the adjustment of the mixture screw back to original specifications. The idle mixture screw is located under the sealed cap. After the overhaul, install a new Tamper Proof Idle Mixture Screw Kit, leaving the cap off. Adjust the idle mixture screw back to the original factory specified number of turns out (see reference list below), and install the tamper proof sealing cap.

5.0L: P/N 3310–864942A01 with sealed idle mixture screw: Screw set at 1–1/2 turns out.

5.7L: P/N 3310–864943A01 with sealed idle mixture screw: Screw set at 1–1/2 turns out.

Needle / Seat Change

MerCarbs are factory equipped with a spring loaded needle. If standard troubleshooting does not correct your problem, change to the solid type needle.



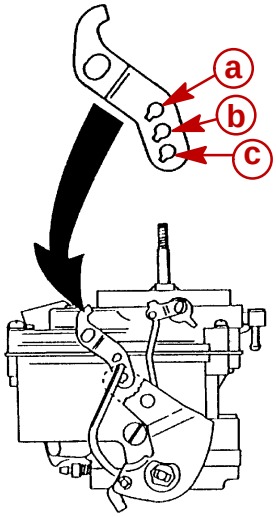
72290

Needle and seat assemblies

a - Spring loaded type needle (kit 3302-804689)
b - Solid type needle (kit 3302-9407)

Adjustable Accelerator Pump Lever

This new 3 hole lever allows you to change the amount of fuel delivered to the engine by the accelerator pump. The center hole will give the same amount of fuel as the single hole lever did. The hole closest to the lever's shaft gives approximately 0.5 cc more fuel and the hole furthest away will give about 0.5 cc less fuel.



73131

a - 0.5 cc less fuel per stroke
b - Full accelerator pump stroke
c - 1.0 cc less fuel per stroke

When installing the 3-hole lever, remove any metal ball that may have been placed in the accelerator pump well to limit pump travel. Also, ensure that the duration spring on the accelerator pump is stock and hasn't had coils removed. Ensure that the correct venturi cluster is being used.

Fuel Delivery System Recommendations

⚠ WARNING

Avoid serious injury or death and property damage due to improper boat design and construction. Always adhere to all applicable Marine Regulations [United States Coast Guard (USCG), European Union - Recreational Craft Directive (EU-RCD), and so on] and the standards they reference [American Boat and Yacht Council (ABYC), Society of Automotive Engineers (SAE), International Standards Organization (ISO), and so on] when designing and constructing the boat and the boat components, such as the engine compartment, fuel delivery system and exhaust system.

The main concern of a boat's fuel system is safety; this must be achieved through a technically sound installation and constant inspection.

The fuel system, from the filler pipe to the fuel pump, is the same in principle for all boats.

The fuel tank is an integrated component of the boat. Refer to the special information on service and maintenance, which you have received from the tank manufacturer.

Only a few points related to function and safety are listed here [Refer to Marine Regulations (USCG, EU-RCD, and so on) and the standards they reference (ABYC, SAE, ISO, and so on) for complete guidelines]:

- All connections should be on the upper side of the tank.
- Where applicable, the drain plug at the lowest point on the tank serves to permit the removal of water and sediment.
- The tank breather pipe must have an inner diameter of at least 13 mm (1/2 in.) and must be fitted with a swan neck to prevent water from entering the tank.

It is recommended that the exact route and length of the fuel lines be established at the first installation of the engine to prevent problems later in connecting them to the engine.

All fuel lines must be well secured. The holes where the lines run through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

The following, but not limited to the following, additional fuel connection related points, *applying to all engines unless otherwise stated*, must be considered [Refer to Marine Regulations (USCG, EU-RCD, and so on) and the standards they reference (ABYC, SAE, ISO, and so on) for complete guidelines]:

1. Fuel pickup should be at least 25 mm (1 in.) from the bottom of fuel tank to prevent picking up impurities.
2. The maximum measured vacuum at the engine's fuel inlet must not exceed 6.9 kPa (2 in. Hg) at 600, 3000, full throttle rpm, and idle rpm.

IMPORTANT: Vacuum reading higher than specified can cause vapor locking with some of today's fuels. It can also cause poor engine performance because of fuel starvation.

IMPORTANT: Excessive fuel system restriction may affect proper air\fuel ratio for allowable exhaust emissions performance.

3. Fuel lines used must be Coast Guard approved (USCG Type A1).

Description	Specification
Inside Diameter of Fittings and Lines	10 mm (3/8 in.) Minimum

4. **On Multi-Engine Gasoline Installations:** It is best to use a fuel pickup and supply line for **each** engine. If a single pickup and line is used, line must be 13 mm (1/2 in.) inside diameter (ID) or larger.
5. Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
6. Fuel lines should be installed free of stress and firmly secured to prevent vibration and/or chafing.
7. Sharp bends in fuel lines should be avoided.
8. A flexible fuel line must be used to connect fuel supply line to fuel inlet fitting on engine to absorb deflection when engine is running.

8 Point Carburetor Check List

To ensure that the carburetor is the cause of the problem, make the following checks BEFORE ordering and installing a new carburetor. If questions 1, 2, 3, 5, 6 and 7 are YES and 8 is NO, the carburetor may not be the problem.

1.	Does the choke close completely before starting?	Y	N
2.	Does the choke open completely during engine warm-up?	Y	N
3.	Is idle mixture screw set correctly? (Engines with Thunderbolt V ignition must have module locked in Base Timing Mode).	Y	N
4.	What is the idle mixture screw setting?	Turn.	
5.	Is the engine idle speed rpm correct?	Y	N
6.	Is venturi cluster discharging fuel by 2000 rpm?	Y	N
7.	Is a good stream of fuel being discharged by both discharge holes in venturi cluster when throttle lever is moved repeatedly while the engine is off.	Y	N
8.	Does the engine flood at idle?	Y	N

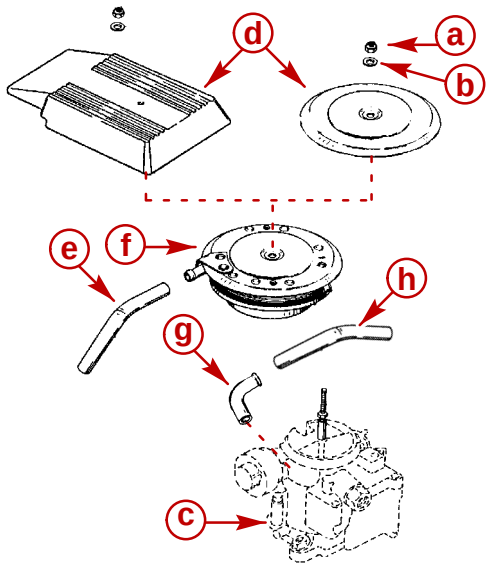
Flooding At Idle RPM

If your engine floods at idle rpm, check the following:

1. Problem in ignition system causing engine to run rough.
2. Idle mixture screw adjusted incorrectly.
3. Bad needle and seat.
4. Incorrect float level or drop.

Maintenance

Flame Arrestor



75844

a - Nut
b - Sealing washer
c - Carburetor
d - Cover (depending on model)
e - Crankcase ventilation hose
f - Flame arrestor
g - Positive crankcase vent (PCV) hose (on carburetor)
h - Positive crankcase vent (PCV) hose

REMOVAL

1. Remove nut.
2. Remove sealing washer.
3. Remove carburetor cover.
4. Remove crankcase ventilation hose from flame arrestor and starboard rocker arm cover.
5. Remove positive crankcase vent (PCV) hose to carburetor tube and port rocker arm PCV valve connection.
6. Remove flame arrestor.

CLEANING AND INSPECTION

1. Clean flame arrestor in solvent and blow dry with compressed air.
2. Clean crankcase ventilation and PCV hoses.
3. Inspect hoses for cracks or deterioration, and replace if necessary.

INSTALLATION

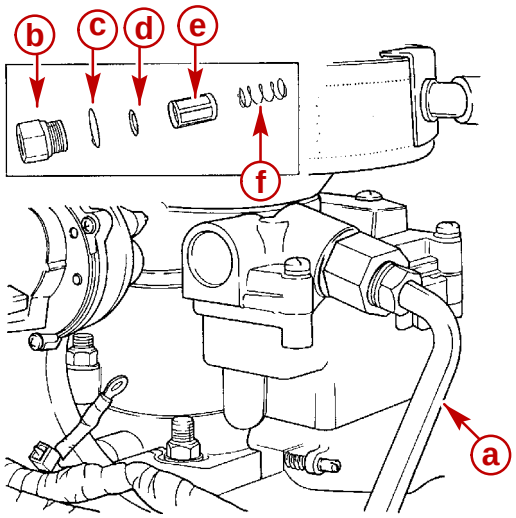
1. Install flame arrestor.
2. Install crankcase ventilation hose to flame arrestor and starboard rocker arm cover.
3. Install PCV hose from port rocker arm PCV valve connection to carburetor tube.
4. Install carburetor cover.
5. Install sealing washer.
6. Install nut. Tighten securely.

Fuel Inlet Filter

NOTICE
Refer to Precautions in this section BEFORE proceeding.

REMOVAL

1. Remove fuel line from fuel inlet filter nut.
2. Remove fuel inlet filter nut and small gasket.
3. Remove large gasket.
4. Remove filter.
5. Remove spring.
6. Remove small gasket from inside filter nut.



72406

a - Fuel line
b - Fuel inlet filter nut
c - Gasket (larger)
d - Gasket (small)
e - Filter
f - Spring

CLEANING

1. Clean filter nut and spring in solvent and dry with compressed air.

INSTALLATION

1. Install spring in carburetor body.
2. Install filter, open end to inlet filter nut.
3. Install small gasket inside filter nut.
4. Install large gasket over filter nut threads.
5. Install fuel inlet filter nut. Torque the fuel inlet filter nut.

Description	Nm	lb-in.	lb-ft
Fuel inlet filter nut	24		18

IMPORTANT: Hold filter nut with wrench while torquing fuel line.

6. Install fuel line. Torque the fuel line.

Description	Nm	lb-in.	lb-ft
Fuel line	24		18

Choke

INSPECTION

The choke does not require any periodic maintenance. However, if a choke malfunction is suspected, the following should be done:

1. With engine turned OFF, remove flame arrestor.
2. Open and close choke several times to check for binding, loose, or disconnected linkages or other signs of damage.
3. If choke or linkage binds or sticks, clean with carburetor choke cleaner.

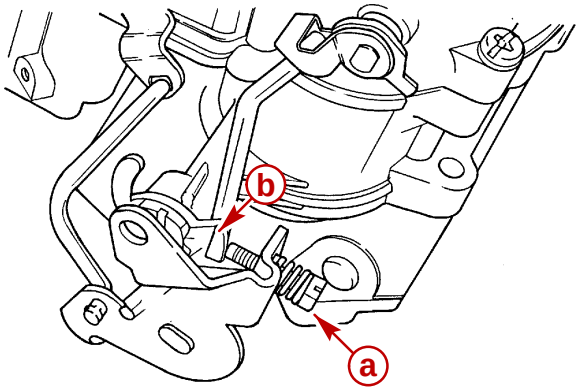
IMPORTANT: Choke valve and shaft and lever assembly is not serviceable. If valve and/or shaft and lever assembly is worn or damaged, air horn assembly must be replaced.

Adjustments

NOTICE
Refer to Precautions in this section BEFORE proceeding.

Pump Rod

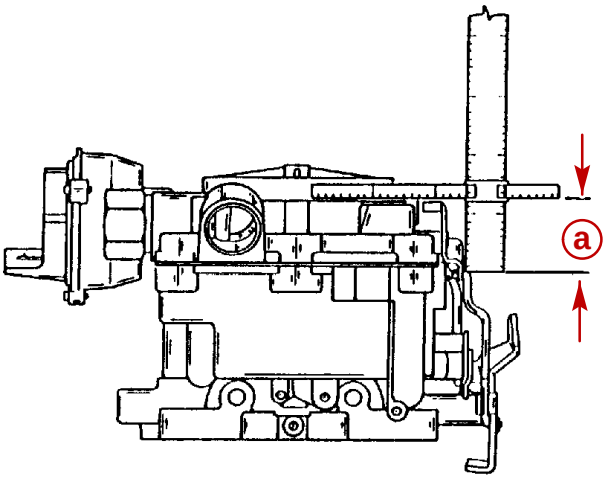
1. Loosen idle speed screw until it no longer contacts idle cam.



72284

a - Idle speed screw
b - Idle cam

2. With throttle valves completely closed, measure from flame arrestor mounting surface to top of pump rod.

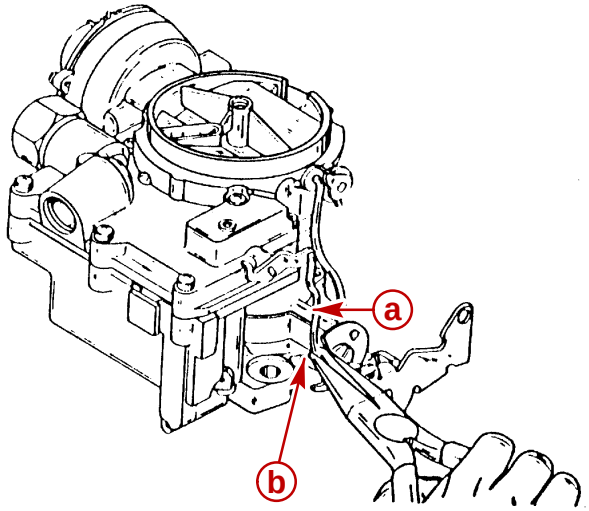


72682

a - 29 mm (1-5/32 in.)

Description	Specification
Distance between flame arrestor mounting surface and top of pump rod	29 mm (1-5/32 in.)

3. Carefully bend pump rod (where shown) to obtain specified dimension.



72683

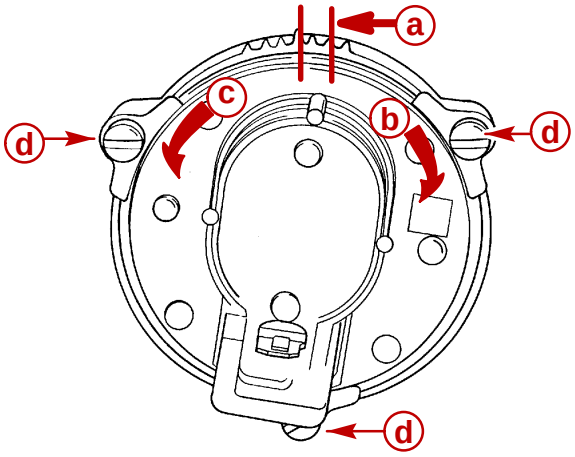
a - Pump rod
b - Bend location

Choke

Normal choke setting: mark on cover is set 2 index marks clockwise from larger, center index mark.

If choke adjustment is necessary:

1. Loosen choke cover retaining screws.
2. Adjust as shown.
3. Tighten screws securely.

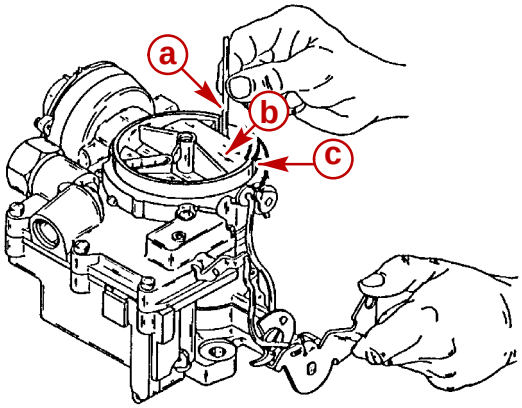


72403

a - Scribed mark
b - More choke
c - Less choke
d - 3 retaining screws

Choke Unloader

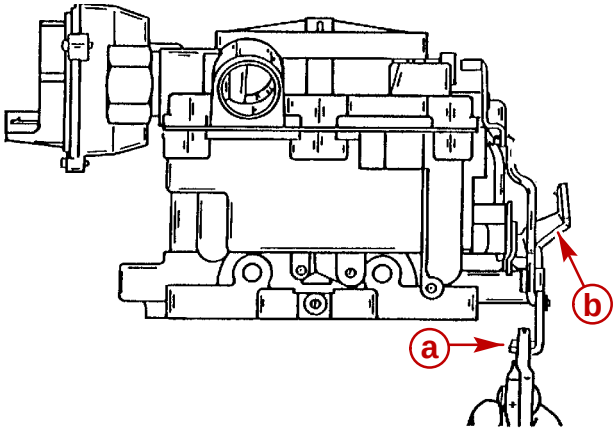
1. Hold throttle valves completely open.
2. Gently press down on choke plate.
3. Using an 0.2 mm (5/64 in.) drill rod, slide rod between upper edge of choke plate and air horn assembly. Rod should just slide through.



72684

a - 0.2 mm (5/64 in.) drill rod
b - Choke plate
c - Air horn

4. Bend tang on throttle lever, if necessary, to obtain clearance.



72685

a - Tang
b - Throttle lever

Sealed Idle Mixture Screw

The carburetor on this engine has a seal on the carburetor mixture screw. This seal prevents adjustment of the fuel mixture setting.

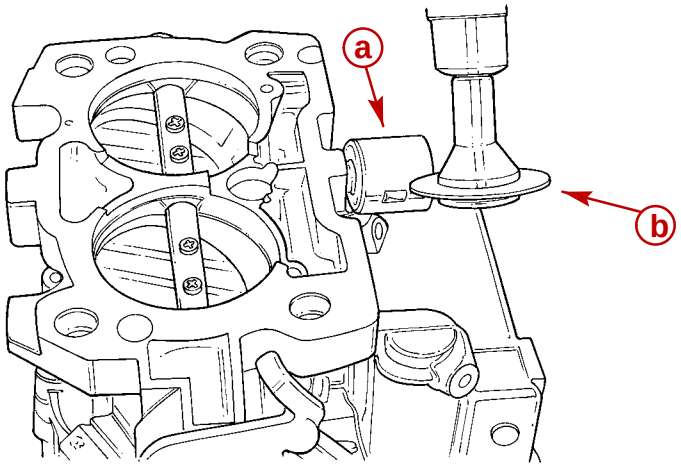
⚠ CAUTION

Do not remove mixture screw seal and/or attempt to adjust fuel mixture setting. Tampering with the mixture setting on this engine could affect the exhaust emissions level, thus voiding the emissions certification. This seal should only be removed by an authorized dealer or emissions testing agency.

REMOVAL

NOTE: *Access to the idle mixture screw can only be made by removing the seal.*

1. Remove the carburetor from the engine.
2. Cut both sides of the outer seal.



79365

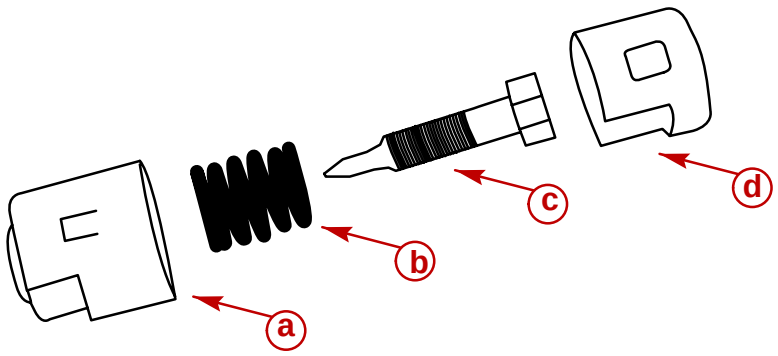
a - Outer seal
b - Cutting wheel

3. Use a screwdriver to pry the outer seal apart at the cuts until you can get the cap out.
4. Remove the idle mixture screw.

NOTE: *It is recommended that additional Tamper Proof Idle Mixture Screw Kits be ordered for stock because the original seal will be damaged during the removal process.*

INSTALLATION

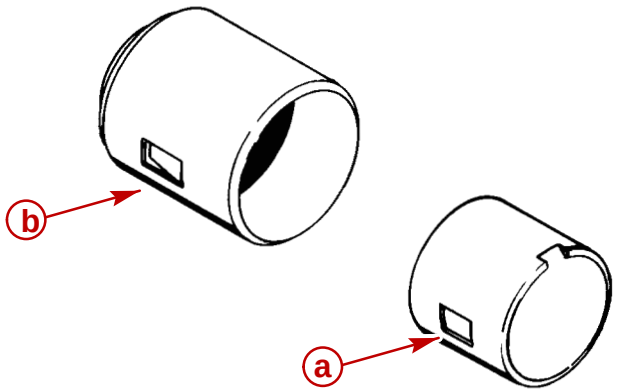
1. Install the new seal cup, spring, and idle mixture screw.



79384

a - Seal cup
b - Spring
c - Idle mixture screw
d - Plug

2. Set the idle mixture screw to 1-1/2 turns out.
3. Align the opening in the plug with the tab on the cup.
4. Push down on the plug until it snaps into place.



73789

a - Opening
b - Tab

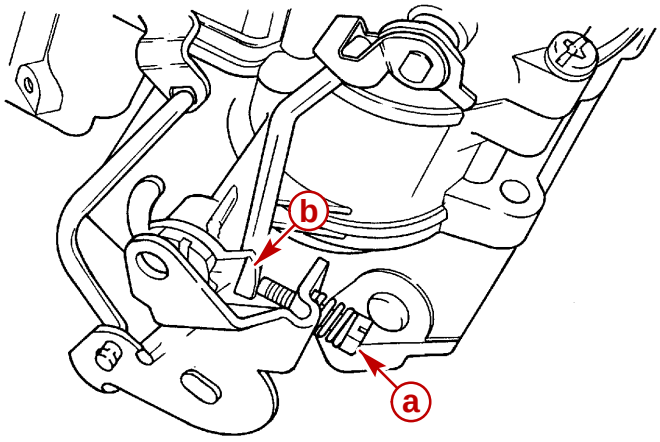
5. Install the carburetor onto the engine.

Initial Idle Speed and Mixture

NOTE: *For carburetors with a seal covering the idle mixture screw, refer to Sealed Idle Mixture Screw for more information.*

IMPORTANT: The following adjustments will provide a sufficient idle speed and mixture for starting engine. Final adjustments must be made with engine running.

1. Loosen idle speed screw until it no longer contacts idle cam. Turn idle speed screw in until it just contacts idle cam, then turn screw in an additional 2 turns.

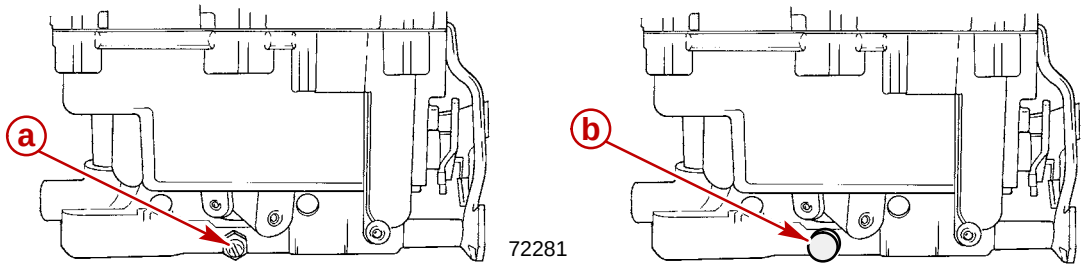


72284

a - Idle speed screw
b - Idle cam

IMPORTANT: Do not turn idle mixture needle tightly against seat (in the following step), as damage to seat and/or needle may result.

2. Turn idle mixture screw in until lightly seated, then adjust outward 1-1/2 turns.



72281

a - Unsealed idle mixture screw
b - Sealed idle mixture screw

Final Idle Speed and Mixture

The ignition module must be locked into the timing mode to adjust idle speed and mixture. Refer to SECTION 4.

Replacing Carburetor

NOTICE
Refer to Precautions in this section BEFORE proceeding.

IMPORTANT: First follow the steps in “8 Point Carburetor Check List” to decide if the problem is with the carburetor.

1. Remove both battery cables from the battery.
2. Remove the carburetor. Refer to Removal.
3. Clean gasket surfaces.
4. Use a new gasket and install new carburetor. Refer to Installation.
5. Hold the carburetor filter nut with a wrench and tighten fuel line fitting securely.
6. Reconnect or install choke wires, vent hoses, and flame arrestor.
7. Adjust carburetor and throttle cable.
8. Install carburetor cover.

Removal

NOTICE
Refer to Precautions in this section BEFORE proceeding.

IMPORTANT: Carburetor problems are often caused by the presence of dirt, water, or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may then be inspected for contamination as carburetor is disassembled.

1. Remove both battery cables from the battery.
2. Remove carburetor cover and flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

3. Turn fuel supply off at fuel tank.
4. Disconnect throttle cable from carburetor.
5. Remove fuel line from fuel inlet nut, using wrench to stabilize fuel inlet nut.
6. Disconnect electric choke.
7. Remove carburetor attaching nuts and washers and remove carburetor.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

8. Remove and discard gaskets.

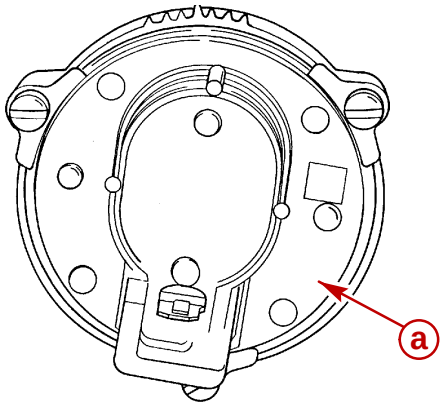
Disassembly

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

The following is a step-by-step procedure for completely overhauling the carburetor removed from engine. Complete overhaul is not always necessary. You should perform only those steps required to repair the carburetor malfunction. Read the instructions carefully to prevent unnecessary steps.

Choke Housing

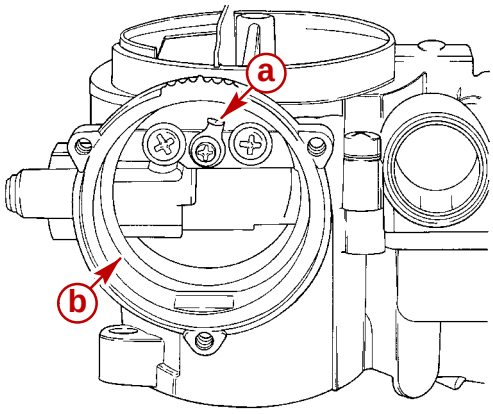
1. Remove choke cover.



72403

a - Choke cover

2. Remove choke lever. Remove choke housing.

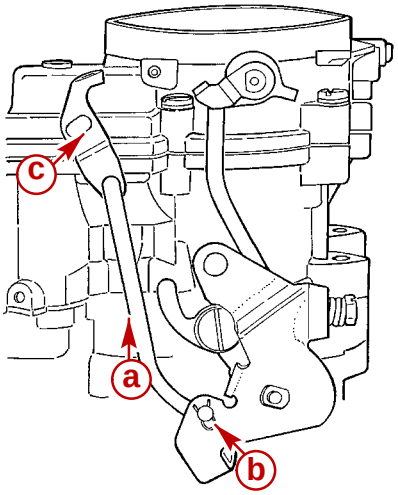


72401

a - Choke lever
b - Choke housing

Air Horn

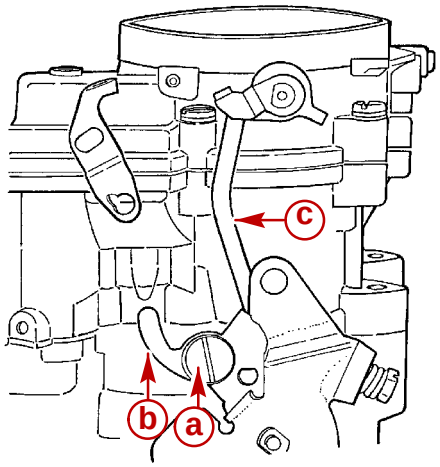
1. Remove fuel inlet filter nut, washers, spring, and filter.
2. Remove accelerator pump rod retaining clip.
3. Pivot rod (as required) until retaining ear on rod and slot in pump shaft and lever assembly align, allowing rod to be pulled out.



72283

a - Accelerator pump rod
b - Retainer clip
c - Pump shaft and lever assembly

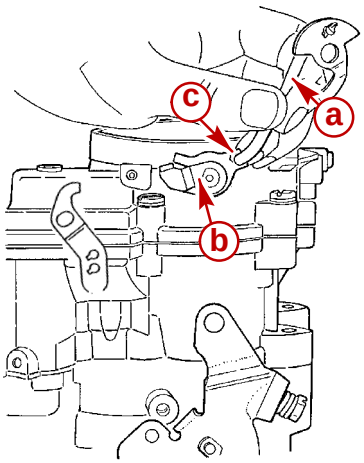
4. Remove idle cam screw.



72282

a - Idle cam screw
b - Idle cam
c - Choke rod

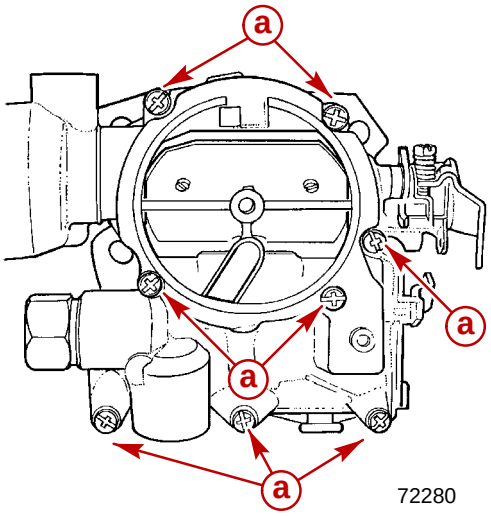
5. Remove choke rod by pivoting rod as required until retaining ear on rod and slot in choke lever align, allowing rod to be pulled out.



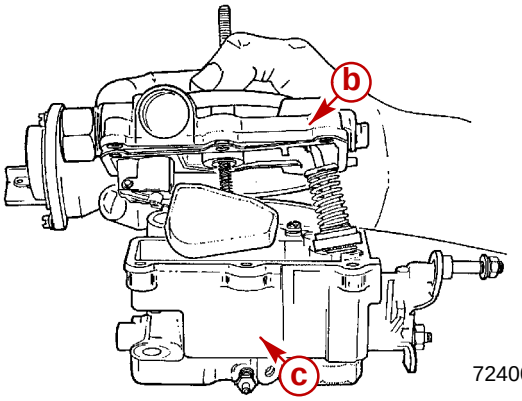
72286

a - Choke rod
b - Choke lever
c - Slot

6. Remove air horn attaching screws.
7. Carefully lift air horn from float bowl assembly.



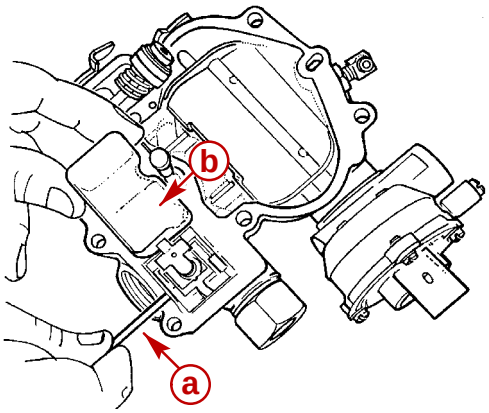
72280



72400

a - Air horn attaching screws
b - Air horn assembly
c - Float bowl assembly

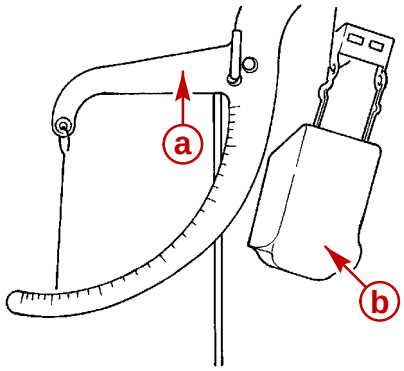
8. Invert air horn and carefully lay on bench.
9. Remove float hinge pin and lift float assembly from air horn.



72288

a - Float hinge pin
b - Float assembly

10. Check float weight.

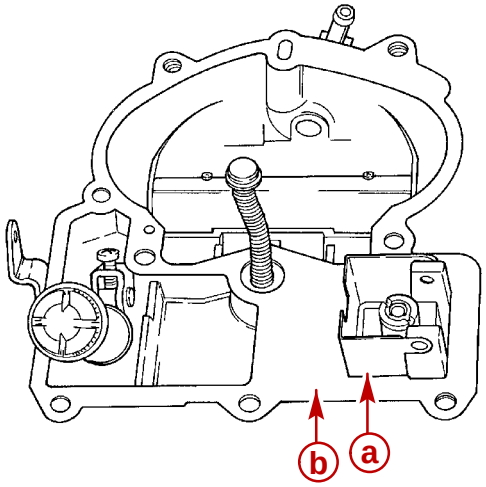


72122

a - Grams scale
b - Float

Description	Specification
Float weight	9 Grams Maximum

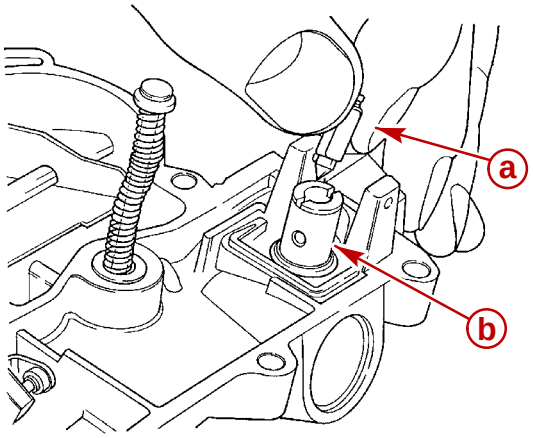
11. Remove air horn gasket and baffle.



72399

a - Baffle
b - Air horn gasket

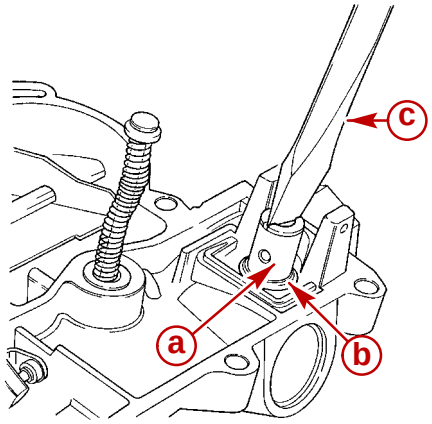
12. Remove needle assembly.



72287

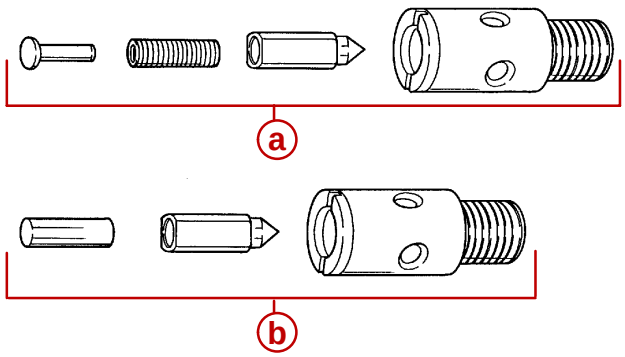
a - Needle assembly
b - Needle seat

13. Remove needle seat.



72289

a - Needle seat
b - Gasket
c - Screwdriver

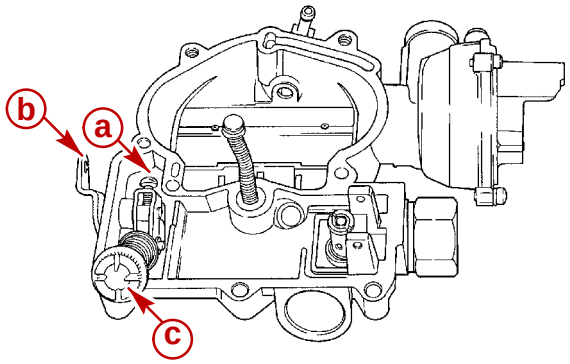


72290

Needle and seat assemblies

a - Spring loaded type needle
b - Solid type needle

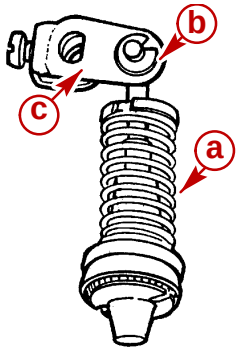
14. Loosen accelerator pump screw.
15. Slide pump shaft and lever assembly (and washer) out of air horn.
16. Remove accelerator pump assembly.



72398

a - Set screw
b - Lever assembly
c - Pump assembly

17. Remove retainer clip and washer from pump shaft and lever assembly, then remove accelerator pump assembly.

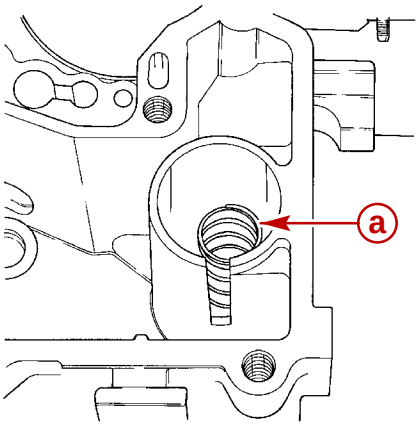


72409

a - Pump assembly
b - Retainer clip
c - Lever assembly

Float Bowl

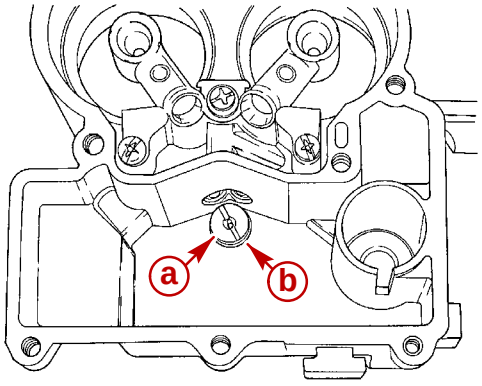
1. Remove accelerator pump return spring from pump well.



72402

a - Accelerator pump spring

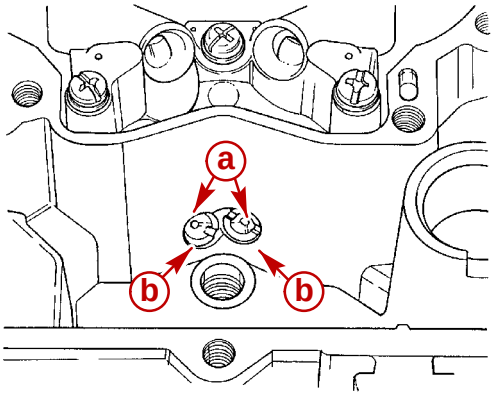
2. Remove power valve assembly and gasket.



72404

a - Power valve assembly
b - Gasket (not shown)

3. Remove main metering jets.

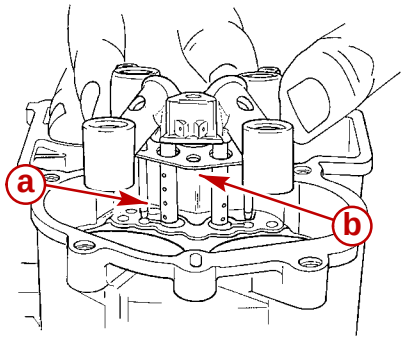


72291

a - Main metering jets
b - Gaskets (not shown)

IMPORTANT: Use care when removing venturi cluster to prevent damaging brass tubes which protrude from bottom of cluster. DO NOT REMOVE TUBES. These tubes are permanently pressed into the venturi cluster and are not replaceable.

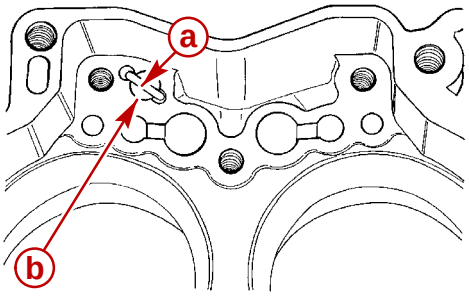
4. Remove venturi cluster screws and carefully lift cluster and venturi gasket straight up.



72397

a - Venturi cluster brass tubes
b - Gasket

5. Using a needle-nose pliers, remove accelerator pump check ball spring retainer. Turn float bowl over to remove spring and check ball.

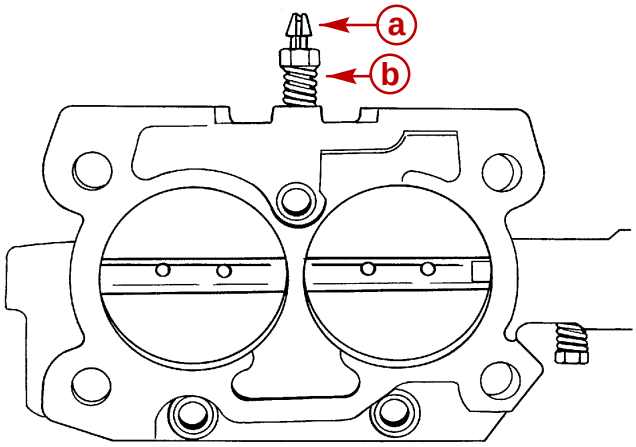


72407

a - Spring retainer
b - Spring and check ball (not shown)

IMPORTANT: Use extreme care when handling carburetor body to prevent damaging throttle valves.

1. Remove idle mixture adjusting needle and spring.



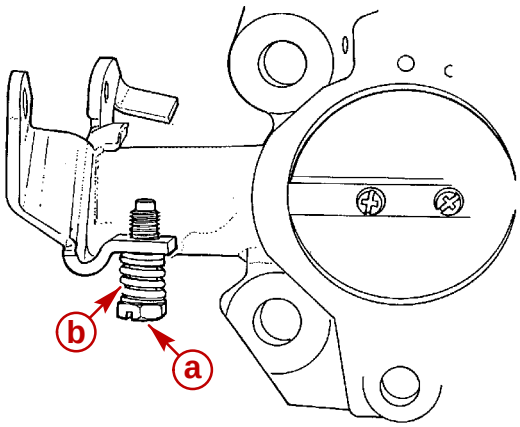
72293

a - Idle mixture adjusting needle
b - Spring

NOTE: *All carburetors on 5.0L and 5.7L engines boxed after January 1, 2003 have a sealed idle mixture screw. The idle mixture screw adjustment is strictly regulated by CARB. However, if the carburetor is overhauled, CARB allows the adjustment of the mixture screw back to original specifications. The idle mixture screw is located under the sealed cap.*

NOTE: *See Sealed Idle Mixture Screw for the procedure for removing the seal on the mixture screw.*

2. Remove idle speed adjustment screw and spring, if replacement is necessary.



72395

a - Idle speed screw
b - Spring

IMPORTANT: Do not remove throttle valves. If any of the throttle parts are found to be worn or damaged, complete carburetor body assembly MUST BE replaced. Assembly can be cleaned in carburetor cleaner.

Cleaning and Inspection

IMPORTANT: Do not use a wire or drill to clean jet passages or tubes in carburetor as this may enlarge orifices and seriously affect carburetor calibration.

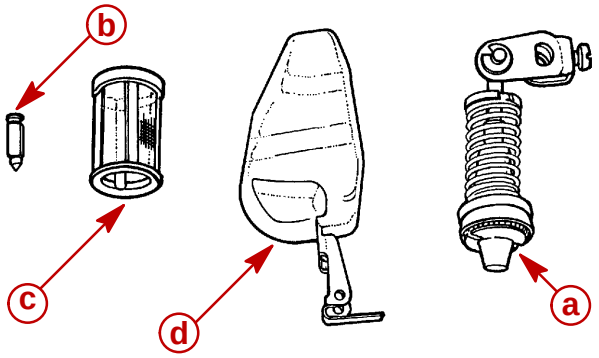
⚠ CAUTION

To avoid damage to carburetor, do not leave carburetor in immersion type carburetor cleaner for more than 2 hours.

IMPORTANT: Do not clean float bowl gasket surfaces with a gasket scraper or knife as sealing bead will be damaged and float bowl replacement will be necessary.

⚠ CAUTION

The float assembly, float needle, accelerator pump plunger, and fuel filter MUST NOT BE immersed in carburetor cleaner, as they will swell, harden, or distort.



72410

a - Accelerator pump plunger
b - Float needle
c - Fuel filter
d - Float assembly

1. Clean all metal parts in a commercial carburetor cleaner until all deposits have been removed. Follow cleaner manufacturer's instructions for proper cleaning and rinsing procedure. Dry parts with compressed air.

2. Using compressed air, blow out all passages in carburetor to remove any foreign material.
3. Wipe off all parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for wear and damage. Pay particular attention to the following:

   a. **Float Needle and Seat**: If float needle or seat is worn or damaged, replace with new needle and seat assembly.

IMPORTANT: Float needle and seat are factory matched and tested and should be replaced as a set only.

   b. **Float Assembly and Hinge Pin:** Check float density (to see if it is saturated with fuel) by comparing weight of float with specifications. If weight is high, float assembly must be replaced. Check hinge pin and holes for wear.

   c. **Fuel and Air Passages:** Passages must be perfectly clean for proper carburetor operation.

   d. **Accelerator Pump Plunger and Return Spring:** Inspect pump plunger cup, pump plunger spring on pump assembly, and return spring.

   e. **Power Piston Spring:** Check power piston spring for weakness or distortion.

   f. **Idle Mixture Needle:** Inspect idle mixture needle. If damaged, needle must be replaced.

   g. **Levers and Linkages:** Check levers, links, and rods for wear.

   h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Ensure throttle valve and shaft open and close completely. Throttle assembly must be replaced if throttle valve and shaft are worn or damaged.

   i. **Choke Valve and Shaft and Lever Assembly:** Check shaft and lever assembly for excessive looseness in air horn assembly. Check choke valve and shaft and lever assembly for binding through entire operating range, making sure valve opens and closes completely. Air horn assembly must be replaced if choke valve and shaft and lever assembly are worn or damaged.

   j. **Inspect Casting** for visible damage. Inspect gasket surfaces. Inspect accelerator pump plunger well for scoring or deposits.

Reassembly

Carburetor Body

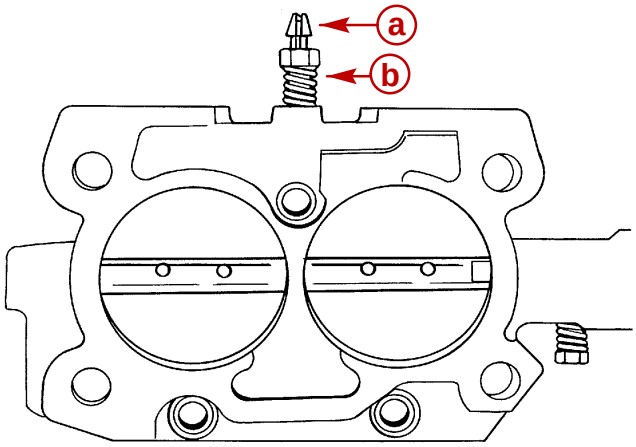
IMPORTANT: Do not force idle mixture needle against seat as damage to needle or seat will result.

NOTE: *After the overhaul, install a new Tamper Proof Idle Mixture Screw Kit, leaving the cap off. Adjust the idle mixture screw back to the original factory specified number of turns out (see reference list below) and install the tamper proof sealing cap.*

5.0L: P/N 3310–864942A01 with sealed idle mixture screw: Screw set at 1–1/2 turns out.

5.7L: P/N 3310–864943A01 with sealed idle mixture screw: Screw set at 1–1/2 turns out.

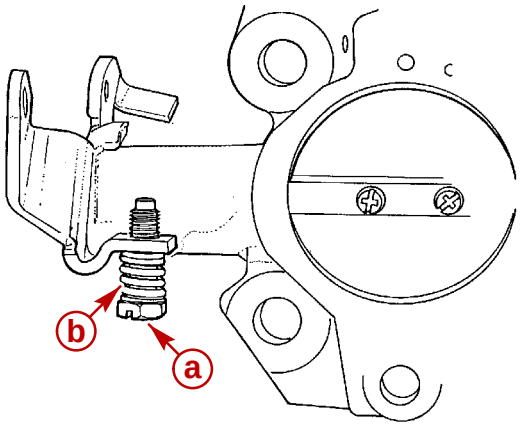
1. Screw idle mixture needle and spring into throttle body until they lightly seat, then loosen needle 1-1/2 turns as a preliminary idle mixture setting.



72293

a - Idle mixing adjusting needle
b - Spring

2. Thread idle speed adjustment screw and spring into throttle lever.



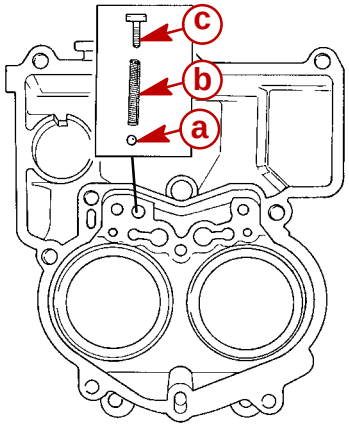
72395

a - Idle speed screw
b - Spring

Float Bowl

IMPORTANT: Place float bowl and throttle assemblies in holding fixture to prevent throttle valves from being damaged.

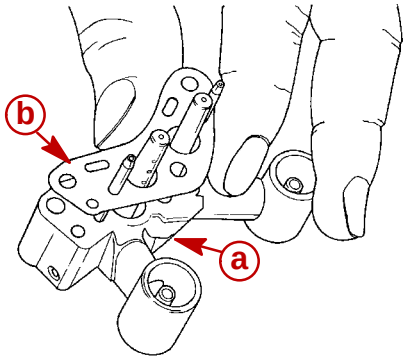
1. Install check ball, spring, and retainer in passage. Push retainer firmly into slots.



72408

a - Check ball
b - Spring
c - Retainer

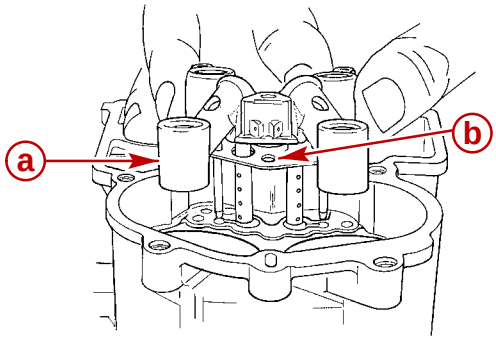
2. Install new gasket on venturi cluster.



72296

a - Venturi cluster
b - Gasket

3. Install venturi cluster in carburetor.

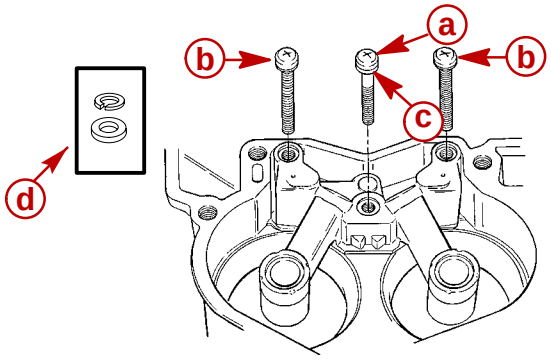


72397

a - Venturi cluster
b - Gasket

4. Install flat washer and new fiber washer on center screw. Lockwashers and flat washers are used on outer screws. Tighten screws evenly and securely.

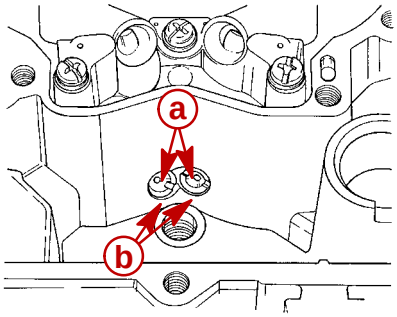
IMPORTANT: Do not damage the fiber washer. A damaged washer will cause improper fueling.



72405

a - Center screw
b - Outer screws
c - Fiber washer
d - Lockwasher and flat washer

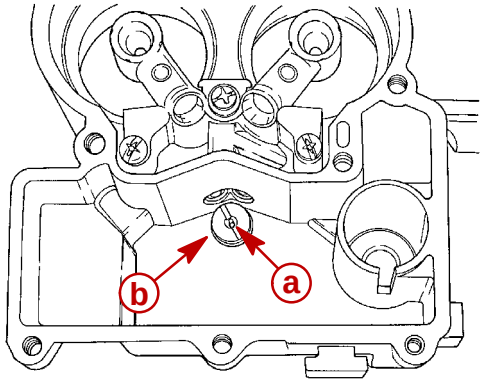
5. Install main metering jets with gaskets. Tighten securely.



72291

a - Main metering jets
b - Gaskets (not shown)

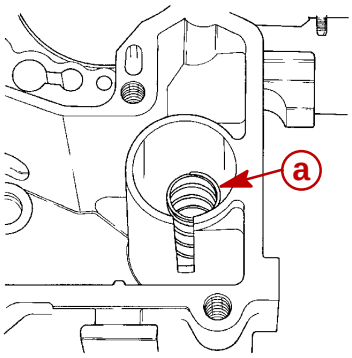
6. Install power valve with new gasket. Tighten securely.



72404

a - Power valve
b - Gaskets (not shown)

7. Place accelerator pump spring in pump well.



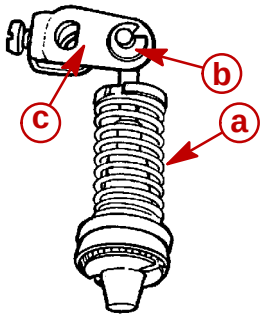
72402

a - Accelerator pump spring

Air Horn

IMPORTANT: Accelerator pump assembly MUST BE installed correctly. If pump assembly is installed incorrectly, top of pump assembly will contact air horn casting.

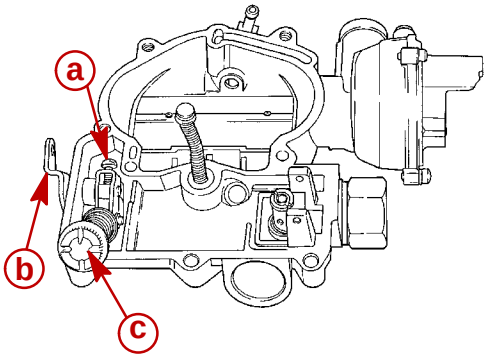
1. If accelerator pump assembly was removed from pump lever, secure pump assembly to pump lever with washer and retainer clip.



72409

a - Pump assembly
b - Retainer clip
c - Pump lever

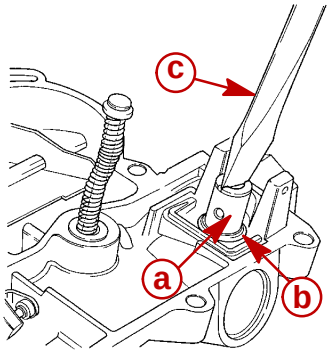
2. Insert pump shaft and lever assembly (and washer) into air horn.
3. Align indexed hole in pump lever with shaft and lever assembly and slide shaft all the way into lever so that shoulder on shaft is hitting lever.
4. Tighten set screw securely.



72398

a - Set screw
b - Lever assembly
c - Pump assembly

5. Install needle seat and gasket. Tighten securely.

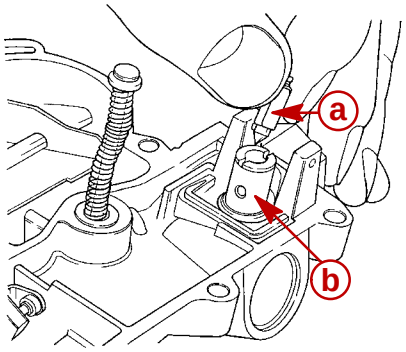


72289

a - Needle seat
b - Gasket
c - Screwdriver

IMPORTANT: Float needle and needle seat are factory matched and tested and should be replaced as a set only.

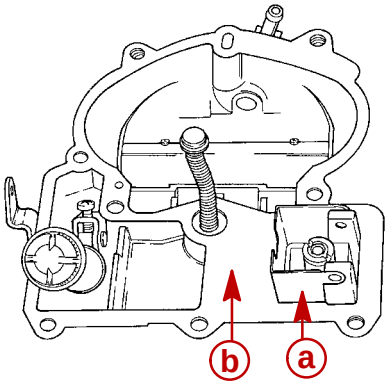
6. Place needle assembly in needle seat.



72287

a - Needle assembly
b - Needle seat

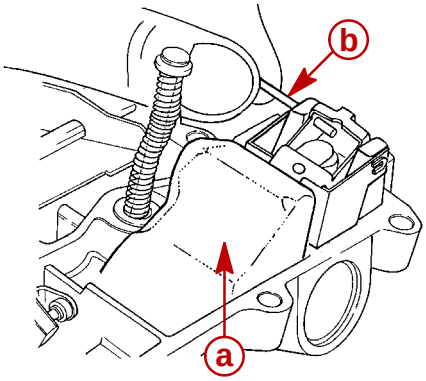
7. Install baffle and gasket.



72399

a - Baffle
b - Gasket

8. Install float assembly and hinge pin. Pivot float assembly up and down on hinge pin to ensure it moves freely.



72297

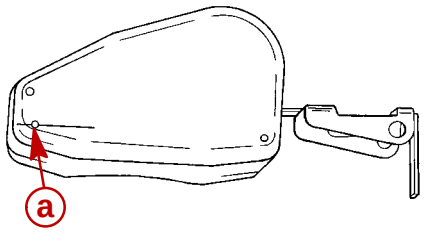
a - Float assembly
b - Float hinge pin

Float Level

1. Turn air horn upside down. Pivot float assembly up and down on hinge pin to ensure it moves freely.

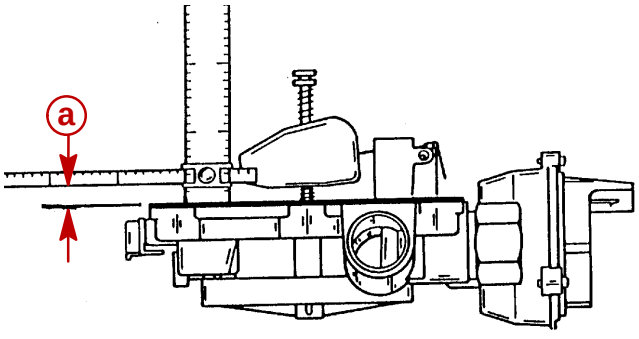
IMPORTANT: Before checking float level, raise float and allow it to fall; DO NOT force downward by hand.

2. Measure float level using Universal Carburetor Gauge. Measure from gasket to toe (dot on end) of float.



72298

a - Measure from this point (dot) to gasket

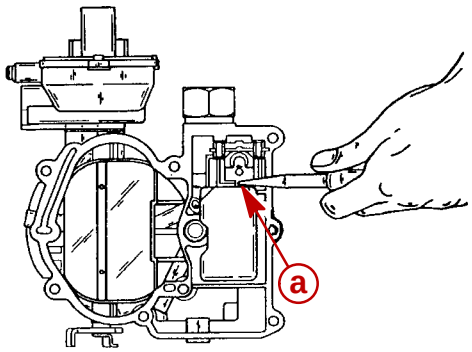


72687

a - Measurement with 2 piece solid inlet needle - 10 mm (3/8 in.)
b - Measurement with spring loaded inlet needle - 9 mm (11/32 in)

Description	Part Number
Universal carburetor gauge	91-36392

3. Bend float arm up or down at point shown to obtain specified dimension.



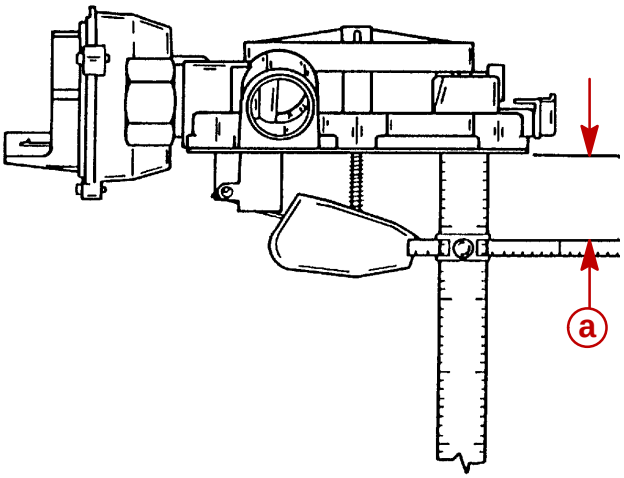
72688

a - Bend location

4. Visually check float alignment after adjustment.

FLOAT DROP

1. Hold air horn right side up to allow float to hang free.
2. Measure float drop using Universal Carburetor Gauge. Measure from gasket air horn to dot on float.

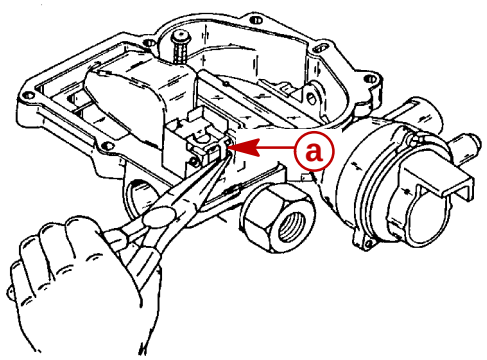


72689

a - Measurement - 24 mm (15/16 in.)

Description	Part Number
Universal carburetor gauge	91-36392

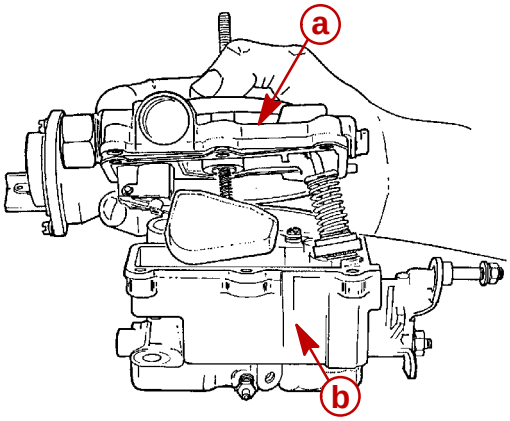
3. Bend float assembly tang to obtain specified dimension.



72690

a - Float assembly tang

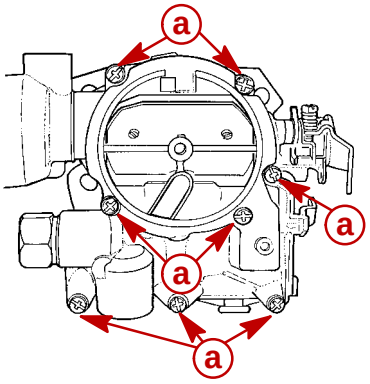
4. Recheck BOTH float level and float drop.
5. Place air horn on float bowl, making sure accelerator pump is correctly positioned in fuel well. Lower air horn straight down to install.



72400

a - Air horn assembly
b - Float bowl assembly

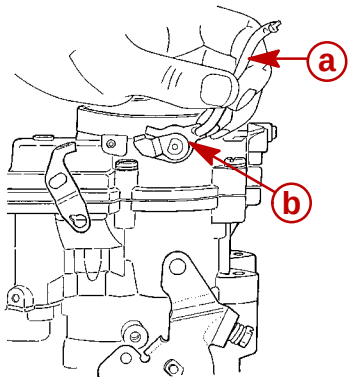
6. Install 7 short and 1 long air horn attaching screws. Tighten screws evenly and securely.



72280

a - Air horn attaching screws

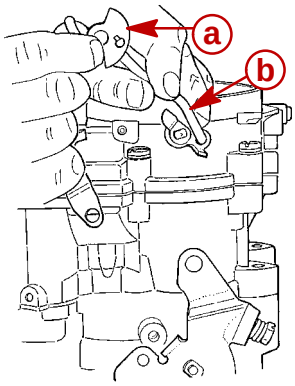
7. Place end of choke rod in choke lever and collar assembly.



72299

a - Choke rod
b - Choke lever and collar assembly

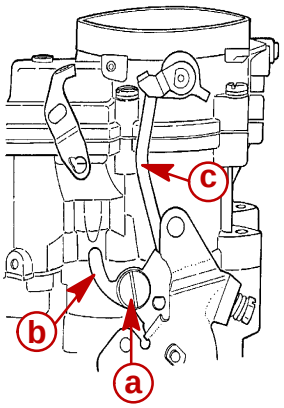
8. Place idle cam on choke rod.



72392

a - Idle cam
b - Choke rod

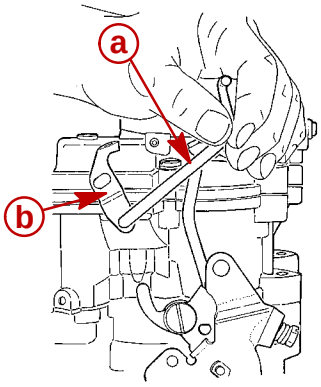
9. Secure idle cam with choke rod installed on cam on float bowl assembly, using screw. Ensure that cam is free to move without binding.



72282

a - Screw
b - Idle cam
c - Choke rod

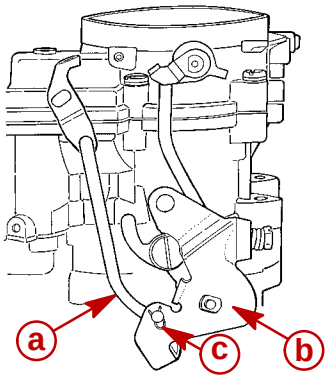
10. Place accelerator pump rod in hole in pump shaft and lever assembly.



72393

a - Accelerator pump rod
b - Pump shaft and lever assembly

11. Insert other end of accelerator pump rod into hole in throttle lever and secure with retainer clip.

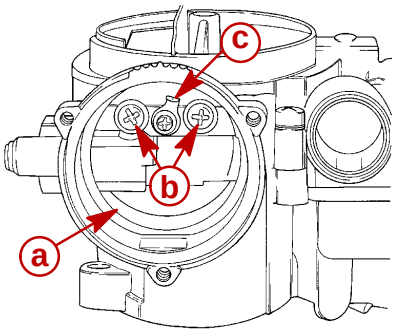


72283

a - Accelerator pump rod
b - Throttle lever
c - Retainer clip

Choke Housing

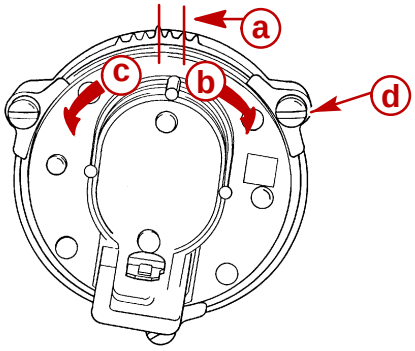
1. Install choke housing on air horn. Tighten screws securely.
2. Install choke lever. Tighten screw securely.



72401

a - Choke housing
b - Choke housing attaching screws
c - Choke lever

3. Install choke cover. Make sure hook on end of choke coil engages with choke lever.
4. Adjust choke cover until index marks align as shown. Tighten screws securely.



72403

a - Scribed mark
b - More choke (richer)
c - Less choke (leaner)
d - Cover screws

Installation

1. Thoroughly clean gasket surfaces and install new gaskets.
2. Place new carburetor base gasket on intake manifold.
3. Install carburetor and secure with nuts and washers. Torque the nuts.

Description	Nm	lb-in.	lb-ft
Carburetor to manifold nuts	27		20

4. If fuel inlet filter nut was disturbed, remove, clean all threads with brush and carburetor cleaner or Quicksilver Leveler, and replace.
5. Connect fuel line to fuel inlet filter nut. Hold filter nut with wrench, tighten fuel line fitting securely.

Description	Nm	lb-in.	lb-ft
Fuel line to carburetor	24		18
Fuel inlet filter nut	24		18

6. Connect electric choke wires to choke cover.
7. Install throttle cable.
8. Install flame arrestor and PCV hose.
9. Install carburetor cover.
10. Reconnect battery cables to battery.
11. Ensure that water is supplied to cooling system.
12. Start engine.
13. Check for gasoline leaks. If leaks exist, stop engine immediately and recheck connections.
14. Adjust idle mixture on 2001-2002 models.

NOTE: *All carburetors with sealed idle mixture screw: the idle mixture screw adjustment is strictly regulated by CARB.*

15. Adjust idle speed.

NOTES:

FUEL SYSTEM

Section 5B - MPI Fuel System Excluding Scorpion Models

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5 B

Replacement Parts Warning

Use of parts other than the recommended service replacement parts will void the warranty on those parts that are damaged as a result.

⚠ WARNING

Electrical, ignition and fuel system components on Mercury MerCruiser Engines and Sterndrives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

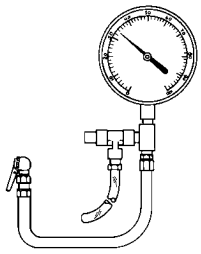
Specifications

Description	Specification
Fuel pump pressure	296.5 kPa (43 psi)

Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Thermal Grease	Cool fuel retainer bracket	Obtain locally
Loctite 242 Threadlocker	Throttle body studs	92-809821
	Fuel cooler mounting studs	
	lower intake manifold bolts	
Loctite 565 PST	Fuel fittings	Obtain locally
Engine oil	Filter sealing ring	Obtain locally
Loctite 5900 Ultra Black RTV Silicone Sealant	Lower intake manifold gaskets	92-809826
	Engine block at lower intake manifold sealing surfaces	

Special Tools

Fuel Pressure Gauge Kit		
 73814	Use to test the fuel pump pressure, includes: 91-803135 fuel pressure adapter kit 91-806901 fuel pressure tee 91-881833A1 160 psi gauge	91-881833A2

Precautions

⚠ WARNING

Avoid personal injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

⚠ WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Ensure that ignition key is OFF. Do not smoke or allow sources of spark or flame in the area while changing fuel filters. Wipe up any spilled fuel immediately.

⚠ WARNING

Ensure that no fuel leaks exist before closing engine hatch.

⚠ WARNING

Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

⚠ CAUTION

Do not operate engine without cooling water being supplied to seawater pickup pump or pump impeller will be damaged and subsequent overheating damage may result.

Fuel Supply Connections

⚠ WARNING

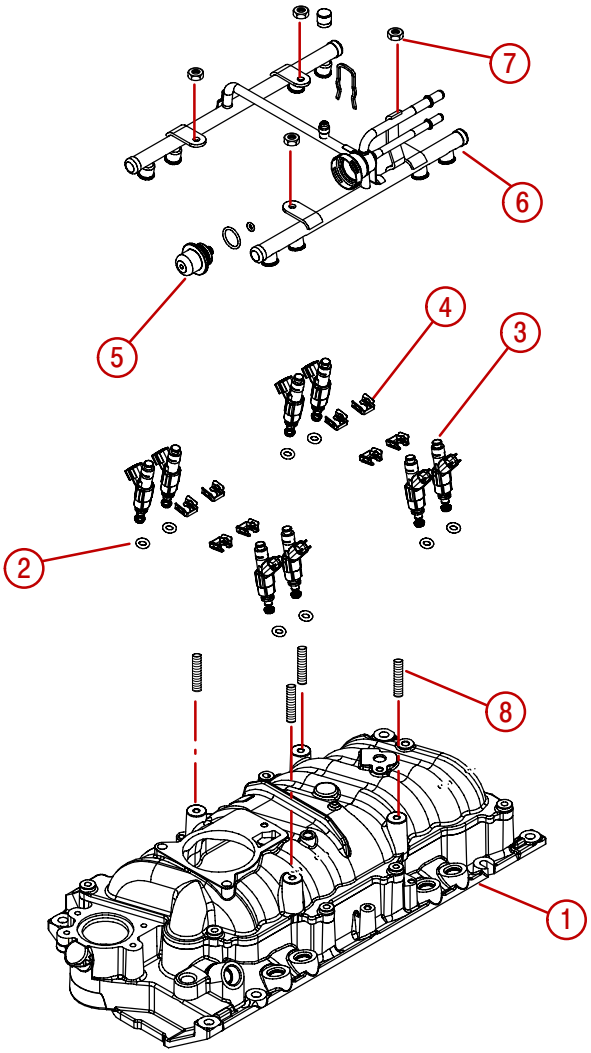
Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

IMPORTANT: The following information is provided to ensure proper installation of brass fittings or plugs installed into fuel pump or fuel filter base:

- **Use Loctite 565 Pipe Sealant with Teflon on threads of fuel inlet fittings or plugs. DO NOT USE TEFLON TAPE.**
- **Fuel inlet fittings or plugs should first be threaded into fuel pump or fuel filter base until finger-tight.**
- **Fuel inlet fittings or plugs should then be tightened an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVERTIGHTEN.**
- **To prevent overtightening when installing a fuel line, the brass fittings should be held with a suitable wrench as fuel inlet fittings are tightened securely.**

Exploded Views

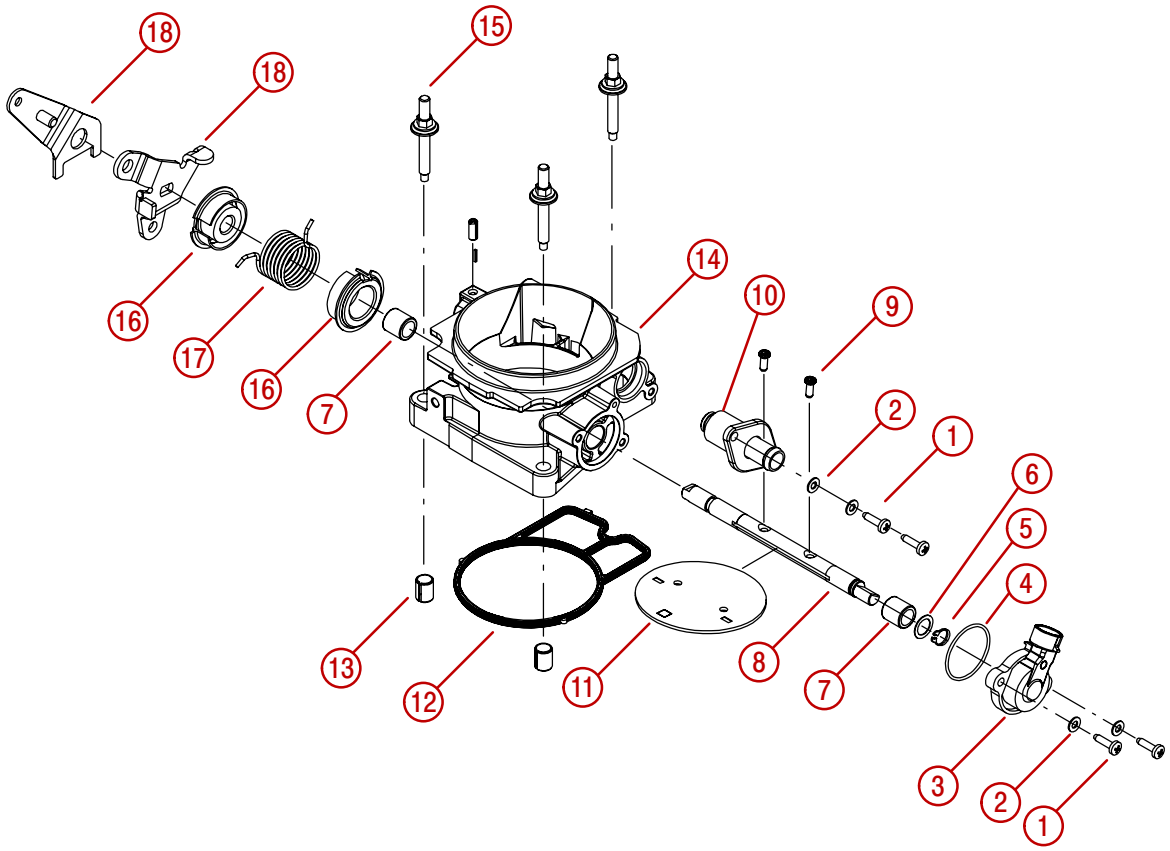
Fuel Rail and Injectors



77833

1 - Intake manifold
2 - O-rings (8)
3 - Fuel injectors (8)
4 - Fuel injector retainer clip
5 - Schrader valve (fuel pressure relief)
6 - Fuel rail
7 - Fuel rail nuts
8 - Fuel rail studs

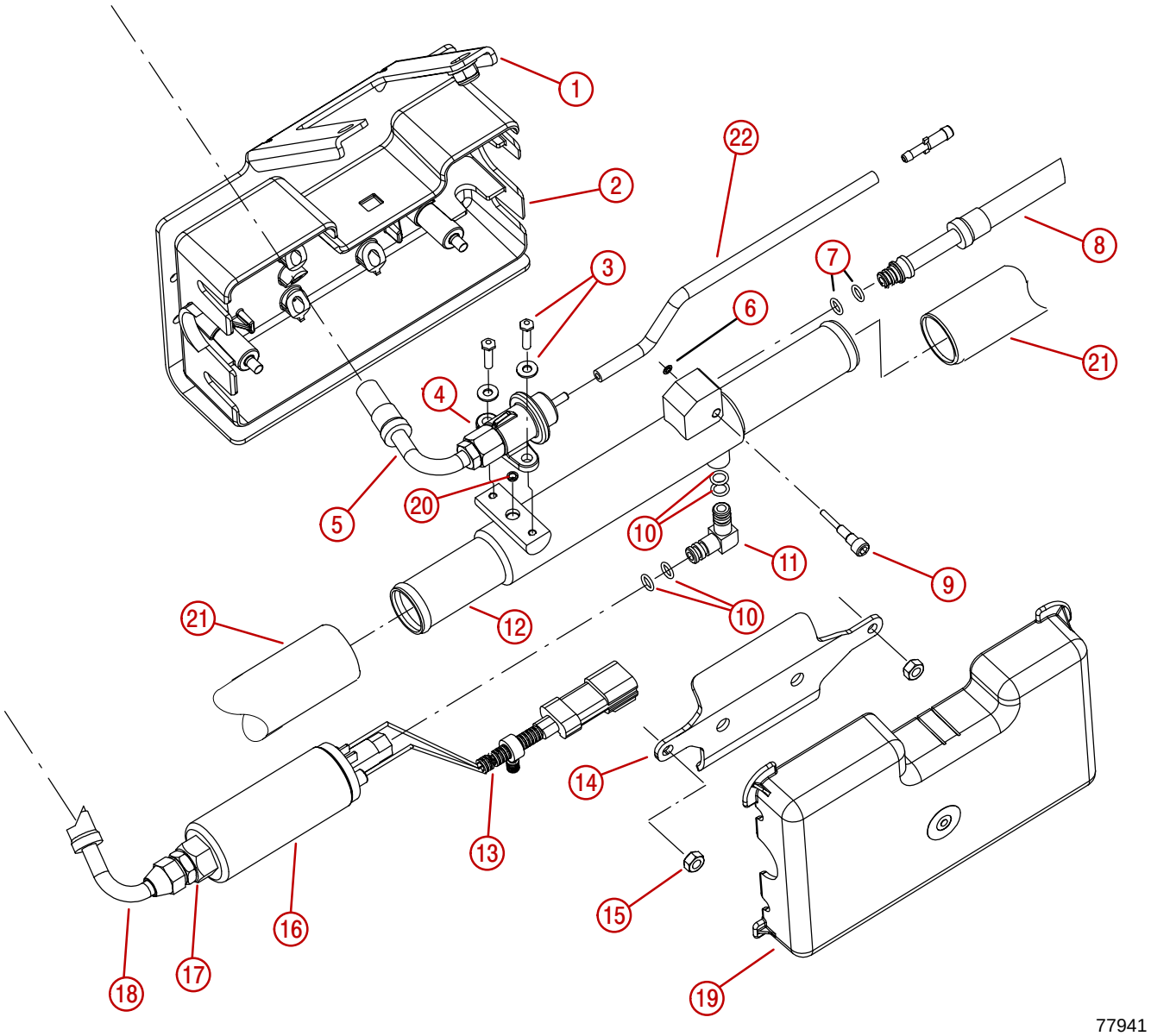
Throttle Body



77840

1 - Bolt (2)
2 - Washer (2)
3 - Throttle position sensor
4 - O-ring
5 - C-clip
6 - Washer
7 - Spacer
8 - Throttle plate bar
9 - Rivet (2)
10 - IAC plug
11 - Throttle plate
12 - Sealing ring
13 - Alignment dowels (2)
14 - Throttle body
15 - Throttle body studs (3)
16 - Spring cover
17 - Spring
18 - Throttle cable bracket

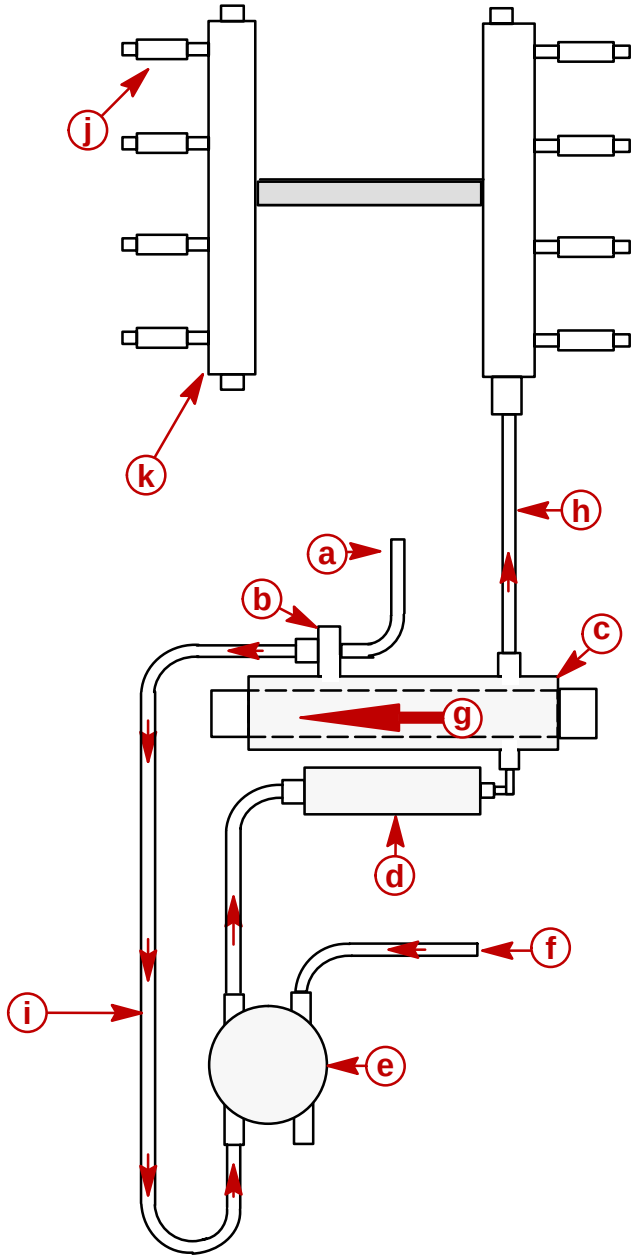
Cool Fuel System



77941

1 - Bracket
2 - Cover base
3 - Screw and washer (2)
4 - Fuel pressure regulator
5 - Return fuel line
6 - Retaining ring
7 - O-rings (2)
8 - Fuel line, fuel pump-to-fuel rail
9 - Stepped screw
10 - O-rings (4)
11 - Elbow fitting
12 - Fuel cooler
13 - Fuel pump wiring harness
14 - Retainer bracket
15 - Nut (2)
16 - Electric fuel pump
17 - Inlet fitting
18 - Fuel line inlet
19 - Cover
20 - Filter
21 - Seawater hoses (hose clamps not shown)
22 - Vacuum hose

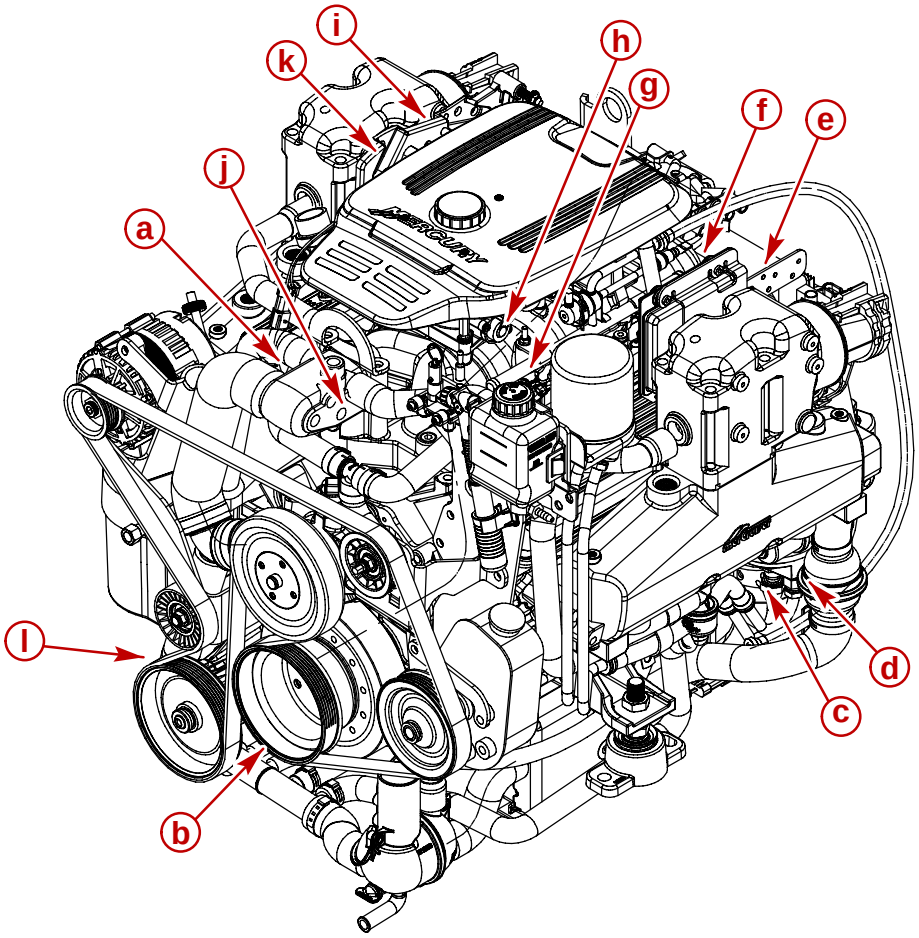
Fuel System Flow Diagrams



78130

a - Vacuum line to intake manifold base
b - Fuel pressure regulator
c - Fuel cooler
d - Electric fuel pump
e - Water separating fuel filter
f - Fuel from tank
g - Water flow
h - Fuel line to fuel rail
i - Excess fuel return to water separating fuel filter
j - Fuel injectors (8)
k - Fuel rail

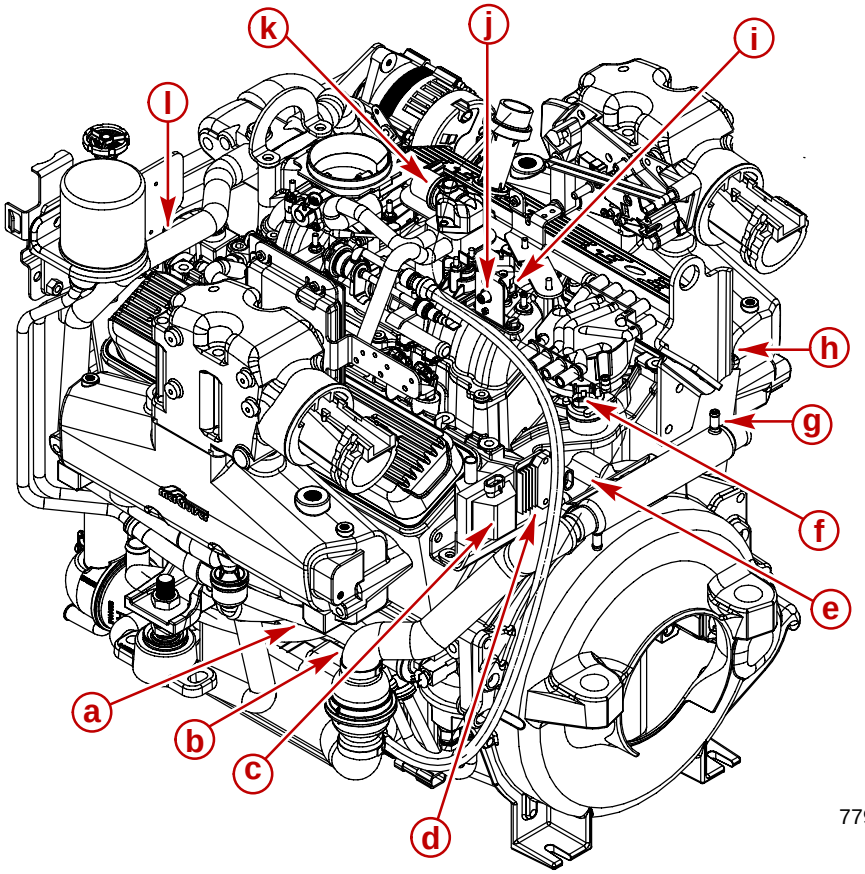
Sensor Locations



77946

a - Water temperature switch
b - Crank sensor
c - Oil pressure switch
d - Oil pressure sender
e - Relays
f - ECM
g - DLC
h - Throttle position sensor (TPS)
i - Shift interrupt switch (Alpha Models)
j - Water temperature sender
k - Gear indication switch (Alpha and Bravo)
l - Water pressure sensor

Sensor Locations (continued)



a - Cool fuel harness connector
b - Knock sensor
c - Ignition coil
d - Ignition module
e - Transmission temperature connectors (if equipped)
f - Distributor connector (should be capped)
g - Water pressure sender
h - Knock sensor
i - Manifold air pressure / temperature
j - Circuit breaker
k - Idle air control
l - MerCathode controller

Torque Specifications

Description		Nm	lb-in.	lb-ft
Distributor hold down clamp bolt		24.4		18
Engine coolant temperature sensor (ECT)		20	180	
Flame arrestor retainer bracket nut		12	108	
Fuel inlet fitting		Hand-tight + 1-3/4 to 2-1/4 turns with a wrench. Do not overtighten.		
Fuel lines		25.7		19
Fuel rail bracket bolt		5.9	53	
Fuel rail retainer nuts		3	27	
IAC bracket nuts		14.9	132	
IAC to bracket bolts		22.3	198	
IAC plug to throttle body screws		2.7	24	
Idle air control valve (IAC)		2.2	20	
Ignition coil studs		11.9	106	
Knock sensor to block		20	180	
Lower intake manifold bolt (each pass in sequence)				
	First pass	3	27	
	Second pass	11.9	106	
	Final pass	14.9	132	

Torque Specifications (continued)

Description		Nm	lb-in.	lb-ft
Manifold air pressure and temperature sensor (MAPT)		5.9	53	
Engine mount stud nuts		40.6		30
Fuel pressure regulator screws		5.9	53	
Retainer bracket nuts		5.6	50	
Stepped screw		9.1	81	
Throttle body nuts		9.9	88	
Throttle body studs		9	80	
Throttle cable bracket nuts		18.9	168	
Throttle position sensor (TPS)		2.2	20	
Upper intake manifold studs				
	First pass	4.9	44	
	Final pass	10	89	
IAC screw 1/4-20 x 25 mm (1 in.) long		10.8	96	
Plenum screw		10.8	96	
Plenum nut		10.8	96	
Knock sensor nut		20	180	
Fuel inlet fitting (boost pump)		23-31		17-23
Fuel filter base bracket to engine mount stud locknut		48-54		35-40
Fuel filter base to bracket locknut		23-31		17-23
Boost pump flange head brace to cylinder block screw		48-54		35-40
Fuel line		20-28.5		15-21

Abbreviations

amp	Amperes	in. Hg	Inches Of Mercury
BARO	Barometric Pressure	INJ	Injector
Bat	Battery Positive Terminal, Battery or System Voltage	kPa	Kilopascal
B+	Battery Positive Voltage	KS	Knock Sensor System
Bps	Beeps	kV	Kilovolts
CAM	Camshaft	mA	milliamperes
cond	Condition	MPR	Main Power Relay
cont	Continuous	MAP	Manifold Air Pressure
Crank	Crankshaft	MAT	Manifold Air Temperature
CAN	Control Area Network	mohms	Milliohms
CKT	Circuit	mSec	Millisecond
CMP	Camshaft Position Sensor	N/C	Normally Closed
Conn	Connector	N/O	Normally Open
CPS	Crankshaft Position Sensor	OBD	On-Board Diagnostic Test
Cyl	Cylinder	PCM	Propulsion Control Module
DDT	Digital Diagnostic Terminal	RAM	Random Access Memory
Deg	Degrees	REF HI	Reference High
Diag	Diagnostic	REF LO	Reference Low
DIS	Distributorless Ignition System	RFI	Resistance Frequency Interval
DLC	Data Link Connector	ROM	Read Only Memory
Dtc	Diagnostic Trouble Code	RPM	Revolutions per Minute
DMM DMT DVOM	Digital Multimeter	SW	Switch
ECM	Electronic Control Module	TACH	Tachometer
ECT	Engine Coolant Temperature	TERM	Terminal
EFI	Electronic Fuel Injector	TPS	Throttle Position Sensor
EMCT	Exhaust Manifold Coolant Temperature	V	Volts
EST	Electronic Spark Timing	VAC	Vacuum
GND	Ground	VDC	Volt Direct Current
IAC	Idle Air Control	VOA	Volt/Ohm/Amp Meter
IGN	Ignition	WOT	Wide Open Throttle

Fuel Delivery System

⚠ WARNING

Avoid serious injury or death and property damage due to improper boat design and construction. Always adhere to all applicable Marine Regulations [United States Coast Guard (USCG), European Union - Recreational Craft Directive (EU-RCD), and so on] and the standards they reference [American Boat and Yacht Council (ABYC), Society of Automotive Engineers (SAE), International Standards Organization (ISO), and so on] when designing and constructing the boat and the boat components, such as the engine compartment, fuel delivery system and exhaust system.

The main concern of a boat's fuel system is safety; this must be achieved through a technically sound installation and constant inspection.

The fuel system, from the filler pipe to the fuel pump, is the same in principle for all boats.

The fuel tank is an integrated component of the boat. Refer to the special information on service and maintenance, which you have received from the tank manufacturer.

Only a few points related to function and safety are listed here [Refer to Marine Regulations (USCG, EU-RCD, and so on) and the standards they reference (ABYC, SAE, ISO, and so on) for complete guidelines]:

- All connections should be on the upper side of the tank.
- Where applicable, the drain plug at the lowest point on the tank serves to permit the removal of water and sediment.
- The tank breather pipe must have an inner diameter of at least 13 mm (1/2 in.) and must be fitted with a swan neck to prevent water from entering the tank.

It is recommended that the exact route and length of the fuel lines be established at the first installation of the engine to prevent problems later in connecting them to the engine.

All fuel lines must be well secured. The holes where the lines run through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

The following, but not limited to the following, additional fuel connection related points, *applying to all engines unless otherwise stated*, must be considered [Refer to Marine Regulations (USCG, EU-RCD, and so on) and the standards they reference (ABYC, SAE, ISO, and so on) for complete guidelines]:

1. Fuel pickup should be at least 25 mm (1 in.) from the bottom of fuel tank to prevent picking up impurities.
2. The maximum measured vacuum at the engine's fuel inlet must not exceed 6.9 kPa (2 in. Hg) at 600, 3000, full throttle rpm, and idle rpm.

IMPORTANT: Vacuum reading higher than specified can cause vapor locking with some of today's fuels. It can also cause poor engine performance because of fuel starvation.

IMPORTANT: Excessive fuel system restriction may affect proper air\fuel ratio for allowable exhaust emissions performance.

Measuring Vacuum

IMPORTANT: Use an accurate digital vacuum gauge that reads in either in. Hg (inches of Mercury) or (kPa) to check this specification. Common vacuum gauges used to check engine intake manifold vacuum are not accurate enough to make this type of measurement. The recommended gauge is the Cole-Parmer Digital Compound Gauge (30 in. Hg to 99.9 psi) that has an accuracy of within 2 percent of the reading. The part number is P-68950-00.

1. Using a 1/8 in. pipe thread (female, for gauge) to 1/4 in. pipe thread (male, for Gauge Guard), install the O-ring and thread the adapter into the Gauge Guard.

NOTE: *Some Gauge Guards may have 1/2 in. pipe thread.*

2. Turn the gauge and Gauge Guard upside down and fill them both with the specified fluid.
3. Use a small, blunt-tipped (not sharp) object that fits into the opposite side of the Gauge Guard to push up the diaphragm and push out some fluid about 1/8 in. (3 mm). If this is not done, when you thread the gauge into the Gauge Guard, you will create pressure that the adjustment screw on the gauge.

NOTE: *If there is any air in the system, this will effect the accuracy of the reading you take with this gauge.*

4. Quickly turn the gauge over and thread it into the Gauge Guard.

Anti-Siphon Valve

U.S. boating standards and regulations specify that an anti-siphon valve be used on any application where any portion of the fuel line falls below the top of the fuel tank. This valve serves to minimize the amount of fuel that could leak into the bilge of the boat in the event of a fuel system leak. A mechanical anti-siphon valve or an electrically operated fuel shut off valve is acceptable for this purpose and should be installed in accordance with industry standards and the manufacturer’s instructions. The mechanical valve must be carefully sized to the fuel pressure head produced in a given application (a function of the fuel level height between the lowest and highest point in the system). The valve must check the flow of fuel when the engine is not running, yet avoid excessive restriction when the engine is operating. An overall fuel system pressure drop of 6.9 kPa (1 psi) or less is desirable but may not be achievable in all cases. In these cases, it is recommended that an electric fuel shut off valve be used.

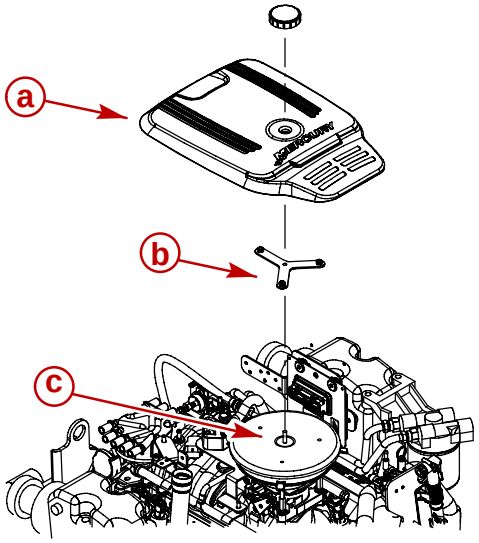
Fuel Pressure Relief Procedure

1. Activate the Schrader valve located on the fuel rail to release pressure.

Flame Arrestor

Removal

1. Remove the engine cover, if equipped.
2. Remove the flame arrestor retainer bracket.
3. Remove the flame arrestor from the throttle body.



78020

a - Engine cover
b - Retainer bracket
c - Flame arrestor

Cleaning and Inspection

1. Clean flame arrestor in steam or water.
2. Wear eye protection. Dry flame arrestor with compressed air.

Installation

1. Install the flame arrestor on the throttle body.
2. Install the flame arrestor retainer bracket.

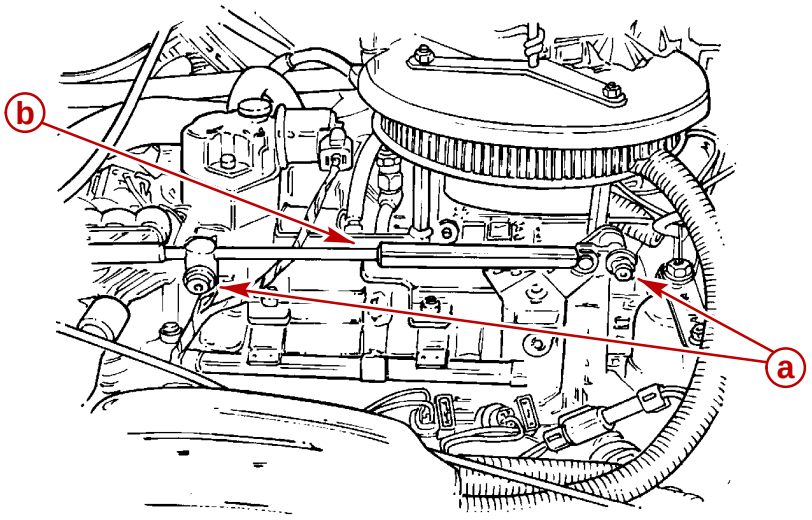
Description	Nm	lb-in.	lb-ft
Flame arrestor retainer bracket nut	12	108	

3. Install the engine cover, if equipped.

Throttle Body

Removal

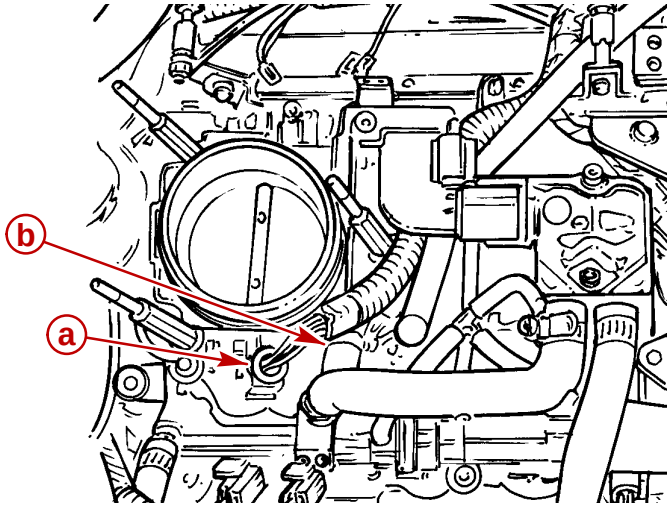
1. Remove the engine cover and the flame arrestor.
2. Disconnect the throttle linkage from the throttle body.



78033

a - Nuts
b - Throttle cable

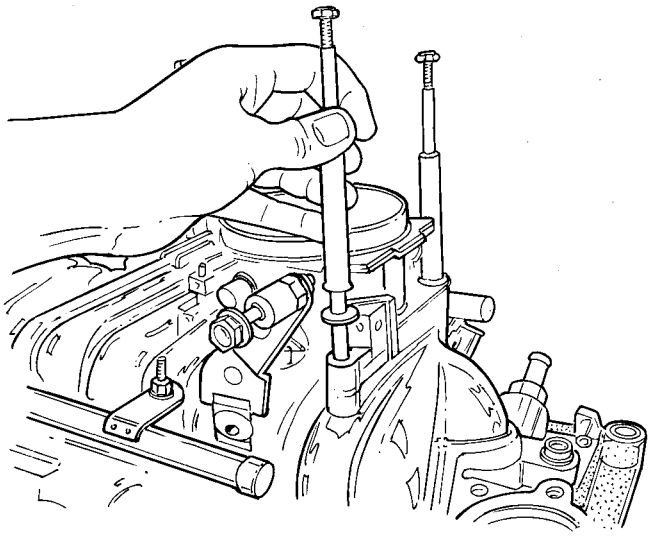
3. Disconnect the harness connector from the throttle position sensor.
4. Remove the IAC hose from the throttle body.



77906

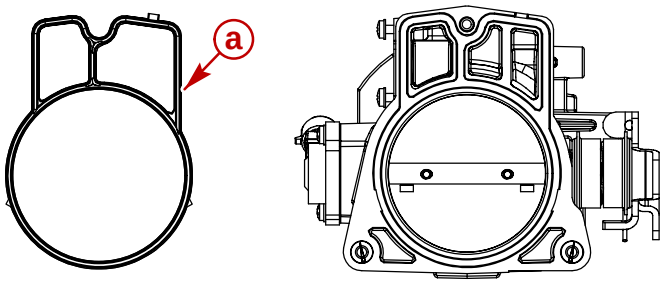
a - Throttle position sensor
b - IAC hose

5. Remove the throttle body attaching studs.



78161

6. Remove the throttle body.
7. Remove and discard the throttle body sealing ring.



78158

a - Sealing ring

IMPORTANT: Insert a clean shop towel into the opening of the intake manifold to prevent foreign material from entering the engine.

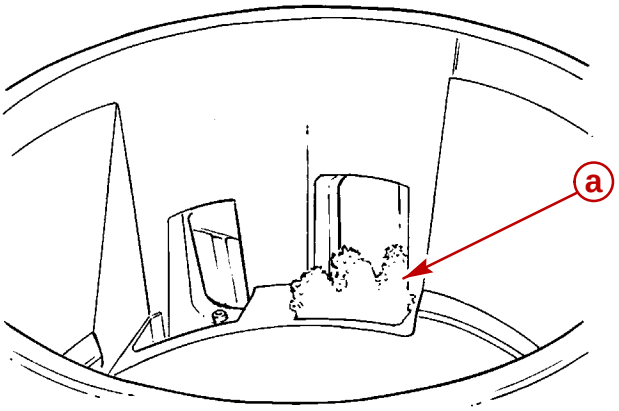
Cleaning and Inspection

IMPORTANT: Do not use cleaners containing methyl ethyl ketone.

IMPORTANT: Do not get solvent or cleaner on the TPS.

IMPORTANT: Do not damage the adapter and throttle body when removing gasket material from adapter and throttle body.

1. Carefully remove all gasket material from adapter and throttle body.
2. Remove the IAC muffler.
3. Clean or replace the muffler if grey or black, as the muffler should be white.



77927

a - IAC muffler installed in throttle body

4. Thoroughly clean all parts of throttle body. Ensure that all passages are free of dirt and burrs.
5. Inspect mating surfaces for damage that could affect gasket sealing.
6. Inspect throttle body for cracks in casting.
7. Inspect throttle plates, linkage, return springs and other components for damage, wear and foreign material.

Installation

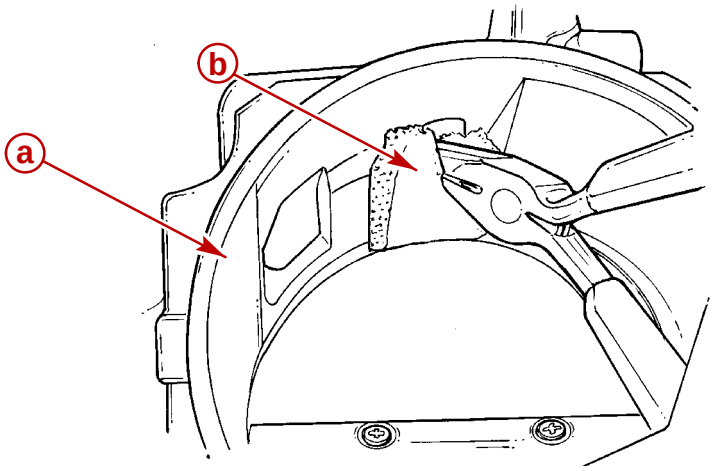
1. Install a new throttle body sealing ring into the groove in the throttle body.
2. Align the dowels and install the throttle body onto the upper intake manifold.
3. If reusing the fasteners, apply adhesive to the threads of the throttle body attaching studs.

Description	Where Used	Part Number
Loctite 242 Threadlocker	Throttle body studs	92-809821

4. Install the throttle body attaching studs. Torque the studs.

Description	Nm	lb-in.	lb-ft
Throttle body studs	9	80	

5. Install the IAC muffler.



77926

a - Throttle body
b - IAC muffler

6. Install the throttle cable bracket.

NOTE: *Ensure that the stud and nut are threading correctly.*

Description	Nm	lb-in.	lb-ft
Throttle cable bracket nuts	19	168	

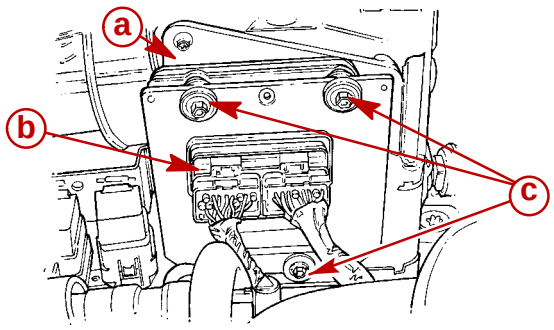
7. Install the IAC hose to the IAC plug.
8. Install the flame arrestor.

Description	Nm	lb-in.	lb-ft
Flame arrestor retainer bracket nut	12	108	

9. Install the engine cover.

Electronic Control Module (ECM)

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. Do not touch connector pins when removing or installing the module.

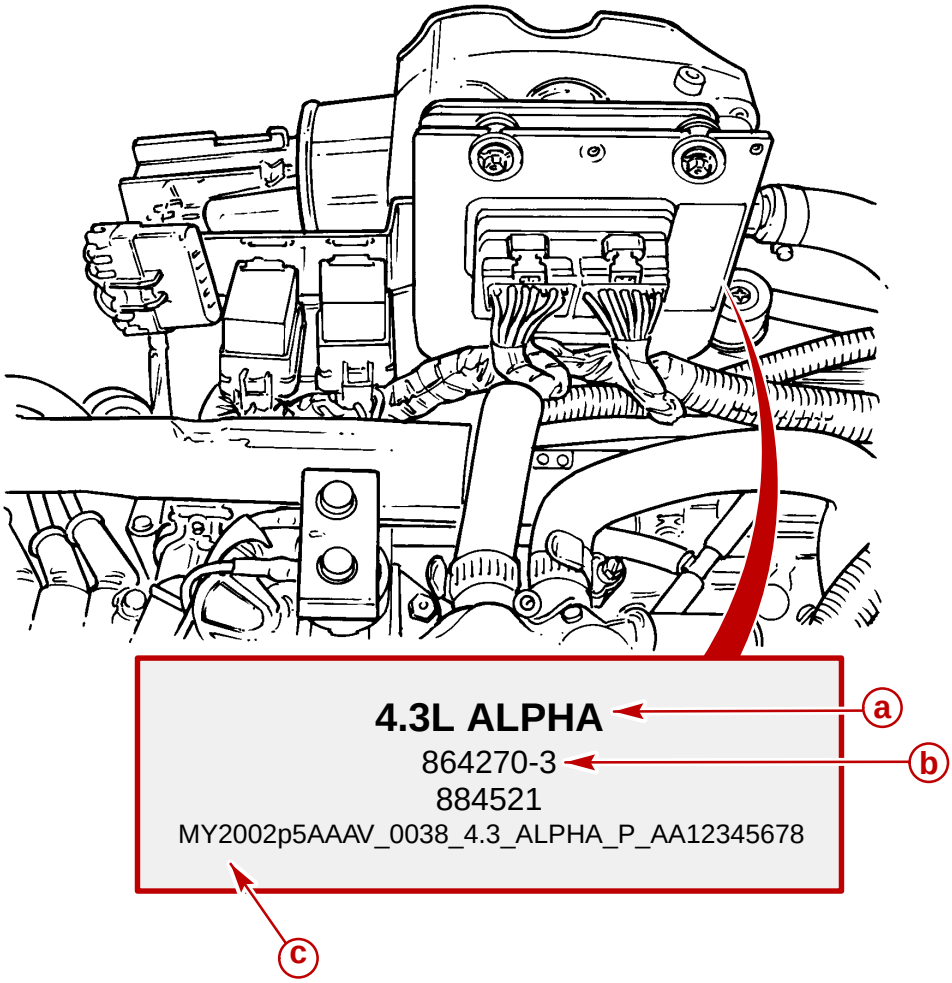


78019

a - ECM bracket
b - Electrical connectors
c - Fasteners

ECM Calibration Label

An ECM can be readily identified by the two wire harness connectors (A–B).



Typical ECM calibration label

a - Engine model
b - Calibration part number
c - Model year

The ECM Calibration label includes the information necessary to determine the calibration that an engine is equipped with from the factory. The top line is the engine model designation. It is important that Alpha ECM's are only used on Alpha models, Bravo ECM's are only used on Bravo models and Inboard ECM's are used only on inboard models. The second line specifies the simple calibration number and version. In this case, it is calibration 864270, version 3. The bottom line lists the model year of the ECM, in this case 2002, followed by detailed identification numbers of the exact calibration. Ensure that you have this information before calling Customer Service.

Removal

1. Disconnect the electrical connectors at the ECM. Do not touch the connector pins.
2. Remove the ECM from the electrical bracket.

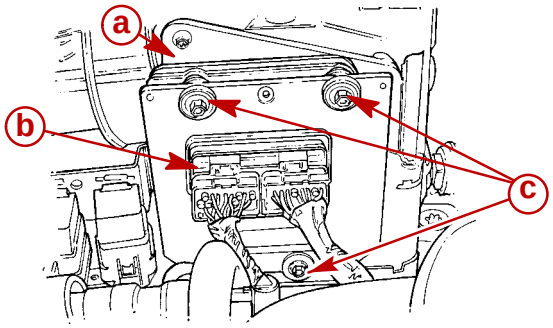
Cleaning and Inspection

1. Clean the exterior of the ECM with a dry cloth. Do not touch the connector pins.
2. Inspect outer surfaces for any obvious damage.
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect the connectors on the wiring harness for corrosion and terminals that may have loose connections.

NOTE: *The ECM is a sealed electrical component. If it is defective, replace the ECM.*

Installation

1. Mount the ECM to electrical bracket using screws and washers.
2. Connect the electrical connectors to the ECM. Do not touch the connector pins.



78019

a - ECM bracket
b - Electrical connectors
c - Fasteners

Boost Pump

NOTE: *The boost pump is not used on Alpha models.*

Removal

⚠ WARNING

Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

NOTE: *Retain all fasteners and hardware unless instructed otherwise.*

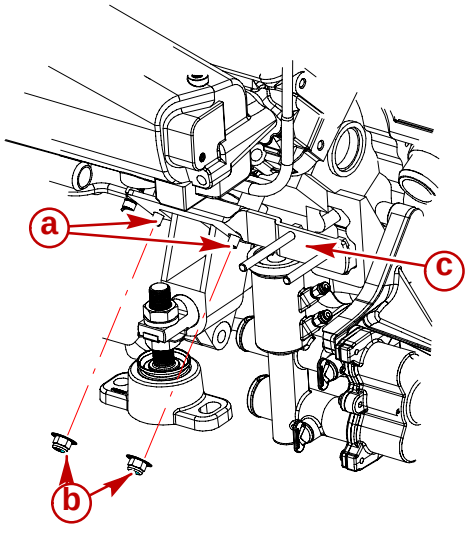
1. Disconnect both battery cables from the battery.

IMPORTANT: Plug the open ends of fuel line connections to prevent fuel leaks and entry of water or contaminates into lines while working.

2. Disconnect and plug the fuel line from the fuel inlet fitting.
3. Remove the fasteners.
4. Remove the fuel pump.
5. Remove the water separating fuel filter.
6. Remove the insulator plate and fuel filter bracket.

Installation

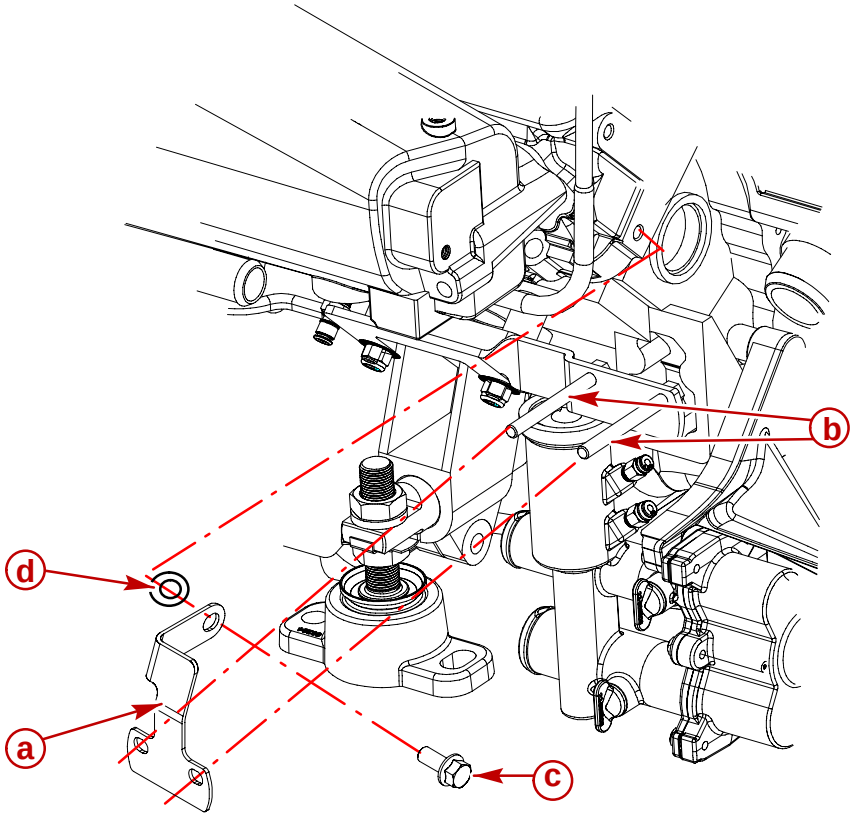
1. Place the fuel filter base bracket on the engine mount studs.
2. Install the two locknuts. Do not tighten at this time.



78452

a - Engine mount studs
b - Locknuts
c - Fuel filter base bracket

3. Place the fuel filter brace onto the fuel filter base bracket studs.



78452

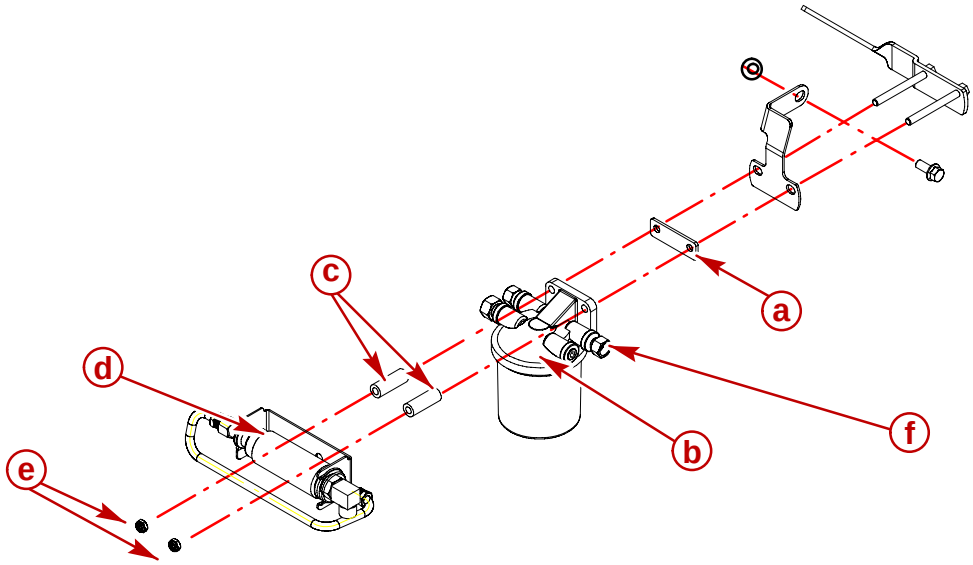
a - Fuel filter brace
b - Bracket studs
c - Screw
d - Spacer

4. Fasten the brace to the cylinder head using the screw and the spacer. Ensure that the spacer is placed between the brace and the cylinder head. Do not tighten at this time.

NOTE: *Ensure that the existing vent tube and harness wire are not trapped between the brace and the cylinder head.*

5. Install the insulator plate and the fuel filter base on bracket studs.
6. Install one collar on each of the bracket studs.
7. Install the boost pump assembly on the bracket studs.
8. Install the two locknuts. Do not tighten at this time.

9. Connect the boost pump fuel line to the fuel base inlet fitting. Do not tighten at this time.



a - Insulator plate
b - Fuel filter base
c - Collars
d - Boost pump assembly
e - Locknuts
f - Fuel inlet fitting

10. Torque the two locknuts securing the fuel filter base bracket to the engine mount studs.

Description	Nm	lb-in.	lb-ft
Fuel filter base bracket to engine mount stud locknut	48-54		35-40

11. Torque the screw securing the filter brace to the cylinder head.

Description	Nm	lb-in.	lb-ft
Flange head brace to cylinder block screw	48-54		35-40

12. Torque the two locknuts securing the boost pump bracket.

Description	Nm	lb-in.	lb-ft
Fuel filter base to bracket locknut	23-31		17-23

13. Torque the boost pump fuel line fitting.

Description	Nm	lb-in.	lb-ft
Fuel line fitting	20-28.5		15-21

14. Connect the harness assembly to the harness connector on the cool fuel box and the engine harness connector.
15. Route the harness assembly along the lower port side of the engine to the rear of the engine and along the lower starboard side of the engine.
16. Connect the harness assembly connector to the harness connector on the boost pump.
17. Install the in-line fuel filter. Refer to the instructions included in the fuel filter assembly.
18. Reconnect both battery cables to the battery.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

19. Supply cooling water to the engine.

⚠ WARNING

Ensure that no fuel leaks exist before closing engine hatch.

20. Start engine and check for leaks.

In-line Fuel Filter

NOTE: *An in-line fuel filter is not used on Alpha models.*

Removal

⚠ WARNING

Be careful when changing the fuel filter. Gasoline is extremely flammable and highly explosive under certain conditions. Ensure that the ignition key is OFF. Do not smoke or allow spark or open flame in the area when changing the fuel filter. Wipe up any spilled fuel immediately.

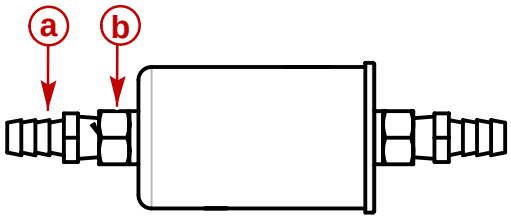
1. Verify the presence of an anti-siphon valve. If no anti-siphon valve is present, plug fuel line from the fuel tank.
2. Remove the existing in-line fuel filter.

Installation

1. Select appropriate size connector for the fuel line and install the connector on the filter.
2. Apply sealant to the male pipe threads on the connectors.

Description	Where Used	Part Number
Loctite 565 PST	Male threads	Obtain locally

3. Torque each connector using a backup wrench on the hex fitting nearest to the connector.

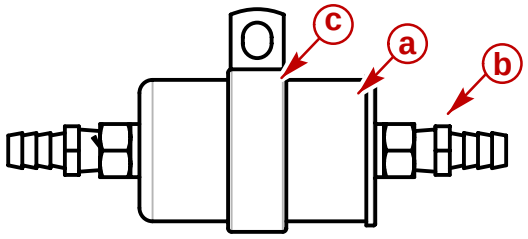


78289

a - Connector
b - Hex fitting

Description	Nm	lb-in.	lb-ft
Connectors	19-27		14-20

4. Insert filter into the mounting clip.



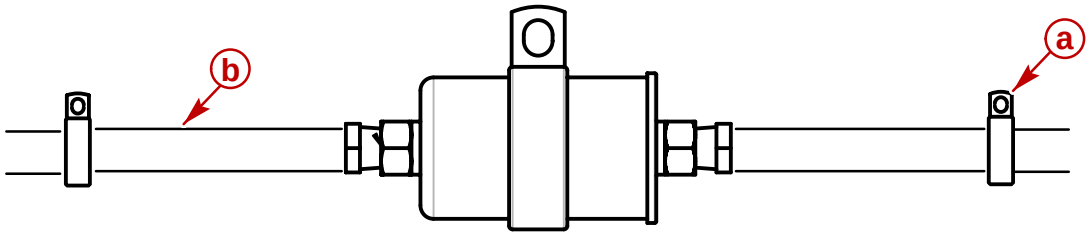
78289

a - In-line filter
b - Connectors
c - Mounting clip

5. Install and torque screw and washer through the mounting clip into the stringer.

Description	Nm	lb-in.	lb-ft
Mounting clip screw	12	108	

6. Insert the hoses onto the barb fittings and fasten using hose clamps.



78289

a - Fuel line stringer clips
b - Fuel line

Description	Nm	lb-in.	lb-ft
Hose clamps	3.4-6.8	30-60	

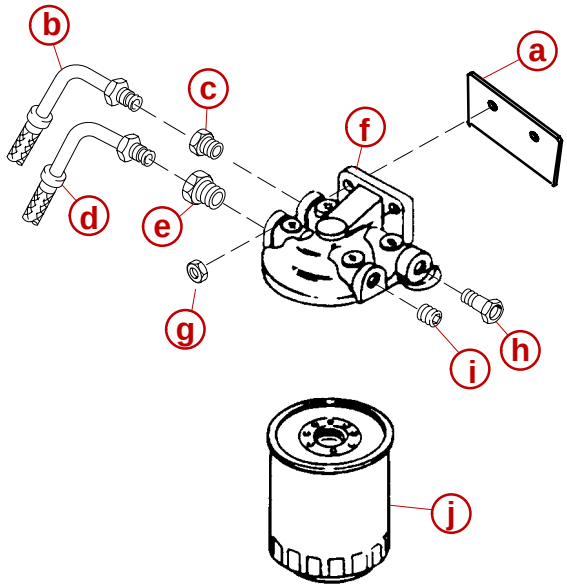
Water Separating Fuel Filter

⚠ WARNING

Avoid Fire or Explosion: The fuel injection system is pressurized during operation. Use care when removing the water separating fuel filter. Fuel could spray on the hot engine causing fire or explosion. Allow the engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.

⚠ WARNING

Be careful when changing the water separating fuel filter. Gasoline is extremely flammable and highly explosive under certain conditions. Ensure the ignition key is OFF. Do not smoke or allow spark or open flame in the area when changing the fuel filter. Wipe up any spilled fuel immediately.



78131

a - Insulator plate
b - Fuel return line from regulator
c - Brass fitting
d - Fuel line to fuel pump
e - Brass Fitting
f - Fuel filter mounting bracket
g - Nut
h - Fuel inlet fitting
i - Plug
j - Water separating fuel filter

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Allow the engine to cool down.

NOTE: *Mercury MerCruiser recommends that the engine be shut off for 12 hours prior to filter removal.*

2. Disconnect both battery cables from the battery.
3. Activate the Schrader valve to relieve fuel pressure.

⚠ WARNING

Avoid Fire or Explosion: The fuel injection system is pressurized during operation. Use care when removing the water separating fuel filter. Fuel could spray on the hot engine causing fire or explosion. Allow the engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.

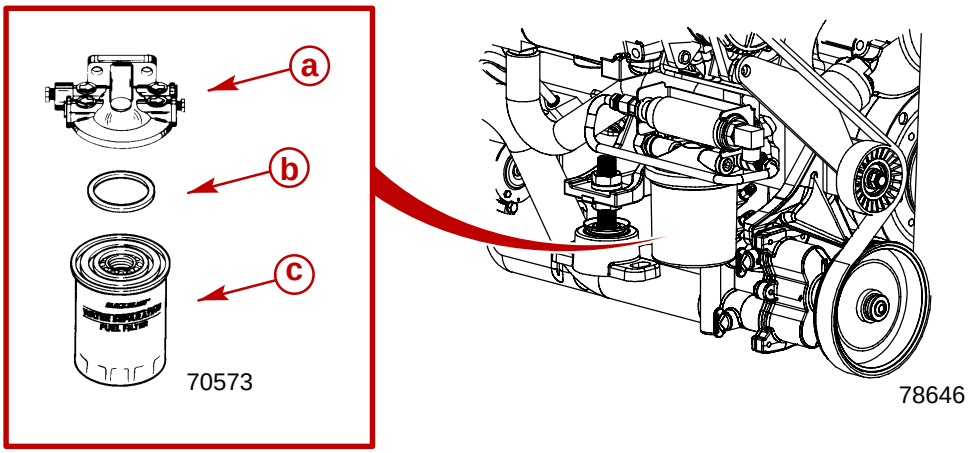
4. Wrap the water separating fuel filter with a cloth to help catch any fuel spills or spray.
5. Remove and discard the water separating fuel filter and sealing ring from the mounting bracket.

Installation

1. Lubricate sealing ring of new filter with engine oil.

Description	Where Used	Part Number
Engine Oil	Filter sealing ring	Obtain Locally

2. Install a new filter. Tighten securely by hand.



a - Fuel filter base
b - Sealing ring
c - Fuel filter

3. Connect both battery cables to the battery.
4. Supply water to cooling system.

⚠ WARNING

Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

5. Start engine.

⚠ WARNING

Ensure that no fuel leaks exist before closing the engine hatch.

6. Check for fuel leaks.

Cool Fuel System

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables from the battery.

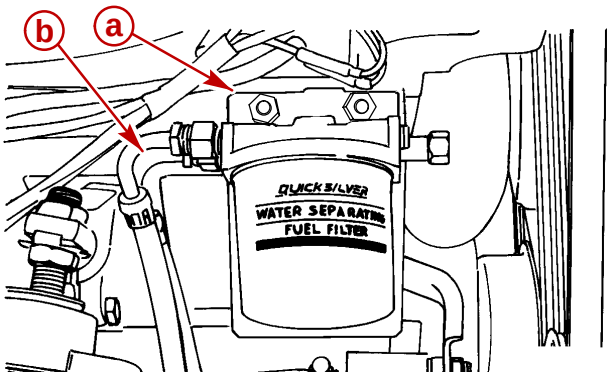
⚠ CAUTION

Ensure that boat is out of the water or seacock is closed and bilge pump is operating before beginning procedure. Excess water in bilge can damage engine or cause boat to sink.

2. Close the seacock, if equipped. If boat is not equipped with a seacock, remove and plug the seawater inlet hose.
3. Drain the seawater system. Refer to **SECTION 1B**.
4. Disconnect the seawater hoses from the fuel cooler.

IMPORTANT: Plug open ends of fuel line connections to prevent fuel leaks and entry of water or contaminates into lines while working.

5. Close fuel shut off valve, if equipped, and remove the fuel tank inlet line from the water separating fuel filter or boost pump. If boat is not equipped with a fuel tank shut off valve, remove the fuel tank inlet line at the water separating fuel filter or boost pump and plug the line.
6. Activate the Schrader valve to relieve fuel pressure.
7. Disconnect fuel lines from water separating fuel filter adapter.



75533

a - Filter adapter
b - Fuel lines

8. Disconnect the fuel line from the rail.
9. Disconnect the fuel pump and boost pump electrical connectors.
10. Disconnect the vacuum hose between the pressure regulator and the intake manifold.
11. Remove the two fuel cooler bracket nuts from the engine mount bracket studs.
12. Carefully remove the cool fuel system assembly.

Disassembly

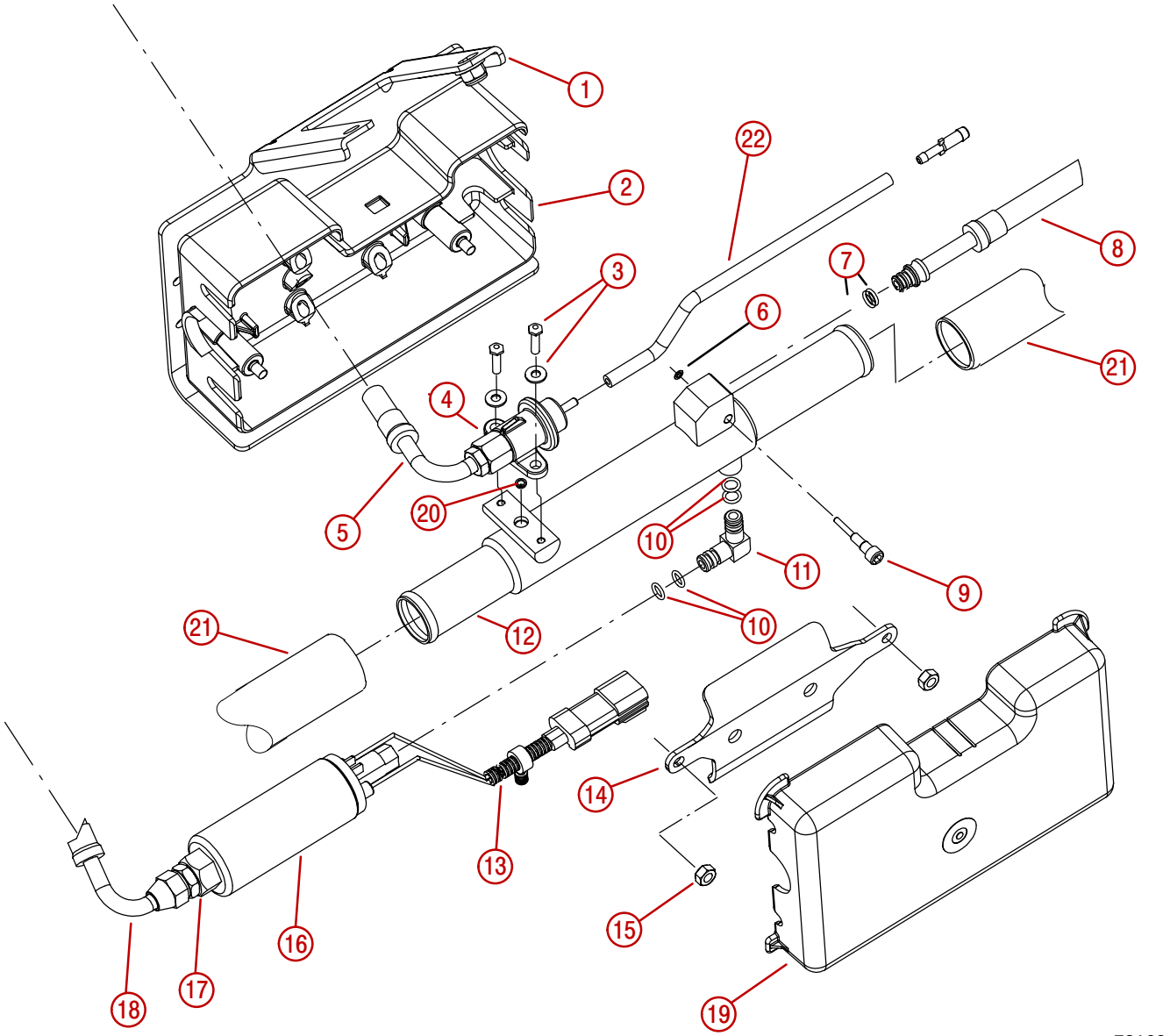
NOTE: *Retain all fasteners and hardware unless instructed otherwise.*

1. Remove the cool fuel system cover.
2. Remove the two nuts from the cool fuel retaining bracket studs.
3. Remove the retainer bracket.
4. Unclip the wiring harness from the cover base.
5. Remove the fuel cooler and the electric fuel pump assembly from the cover base.

IMPORTANT: To prevent loss of the stepped screw used to secure the fuel cooler to fuel rail fuel line, a retainer ring is provided. Do not remove the retainer ring or stepped screw.

6. Loosen the stepped screw and remove the fuel line.
7. Hold the fuel line and fuel pump or fuel cooler fittings securely and remove the fuel lines.
8. Disconnect the elbow fitting and fuel pump from the fuel cooler assembly by pulling firmly.
9. Remove the elbow fitting from the fuel pump by pulling firmly.
10. Hold the fuel line and regulator fittings securely and remove the fuel line.
11. Remove the fuel line fitting from the fuel pressure regulator.
12. Remove the two screws and washers retaining the fuel pressure regulator to the fuel cooler.
13. Remove the regulator.
14. Remove the conical filter from the fuel cooler.

15. Disconnect the vacuum hose from the regulator by pulling firmly.



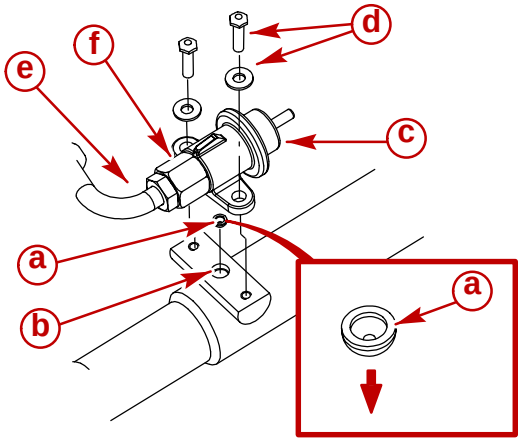
1 - Bracket
2 - Cover base
3 - Screw and washer (2)
4 - Fuel pressure regulator
5 - Return fuel line
6 - Retaining ring
7 - O-rings (2)
8 - Fuel line, fuel pump to fuel rail
9 - Stepped screw
10 - O-rings (4)
11 - Elbow fitting
12 - Fuel cooler
13 - Fuel pump wiring harness
14 - Retainer bracket
15 - Nut (2)
16 - Electric fuel pump
17 - Inlet fitting
18 - Fuel line inlet
19 - Cover
20 - Filter
21 - Seawater hoses (hose clamps not shown)
22 - Vacuum hose

Reassembly

1. Install the small filter (conical side DOWN) in the orifice of the new fuel cooler where the fuel pressure regulator mounts.
2. Install the regulator onto the cooler using the two screws with washers. Torque the screws.

Description	Nm	lb-in.	lb-ft
Fuel pressure regulator screws	5.8	53	

3. Install the fitting into the regulator. Tighten securely.
4. Connect the fuel line to the regulator. Tighten securely.

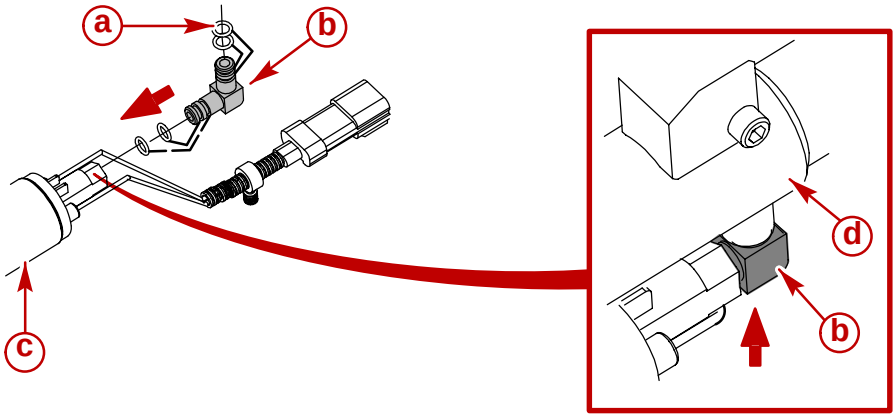


75708

a - Filter
b - Fuel cooler orifice
c - Fuel pressure regulator
d - Screw and washer (2)
e - Fuel line
f - Fitting

5. Install the vacuum hose onto the regulator.
6. Install the 4 O-rings on the fuel pump / cooler elbow fitting.
7. Lubricate O-rings for the elbow fitting with a small amount of liquid dish soap (obtain locally).
8. Install the elbow fitting in the fuel pump.

9. Install the fuel pump with elbow fitting in the cooler assembly.



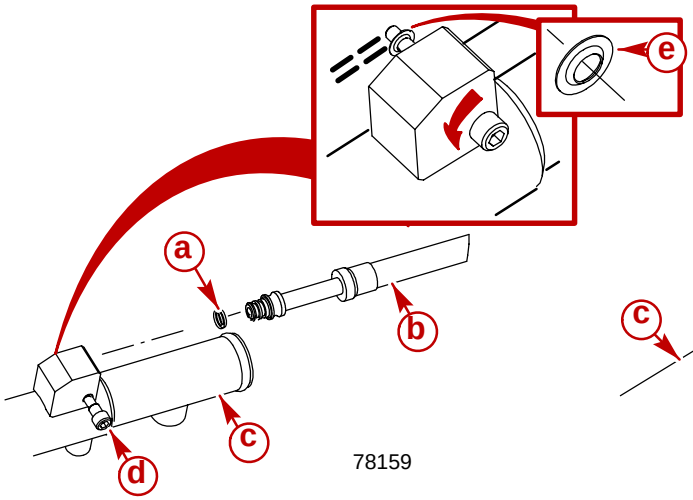
75708

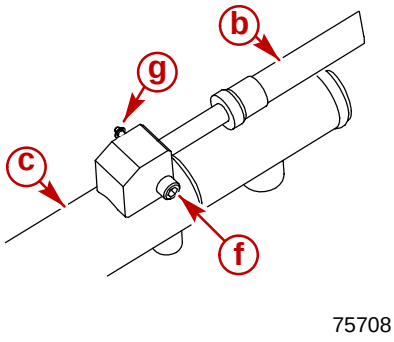
a - O-rings (4)
b - Elbow fitting
c - Fuel pump
d - Fuel cooler

10. Install the fitting into the end of the fuel pump.
11. Install the fuel line for the water separating fuel filter to the fuel pump fitting.
12. Install fuel line seal onto the cooler to fuel rail fuel line where it attaches to the cooler.
13. Completely loosen, but do not remove, the stepped screw that retains the fuel line.
14. Lubricate the fuel line seal with a small amount of liquid dish soap (obtain locally).
15. Insert the fuel line into the cooler orifice. Torque the stepped screw.

Description	Nm	lb-in.	lb-ft
Stepped screw	9	81	

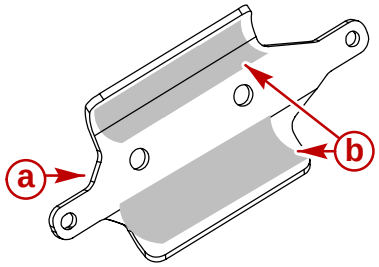
IMPORTANT: To prevent loss of the stepped screw used to secure the cooler to fuel rail fuel line, a retainer ring is provided. Do not remove the retainer ring or stepped screw.





a - Fuel line seal
b - Fuel line, fuel cooler to fuel rail
c - Fuel cooler
d - Stepped screw - loosened to accept fuel line
e - Retainer ring
f - Stepped screw - torqued
g - Retainer ring

16. Position the completed fuel cooler assembly in the cover base.
17. Apply a thin, even coating of lubricant on all of the retainer bracket inside surfaces where it contacts the cooler and the fuel pump when installed.



a - Retainer bracket
b - Lubricant

Description	Where Used	Part Number
Dielectric Grease	Cool fuel retainer bracket	92-823506-1

18. Install the retainer bracket over the cooler and fuel pump. Apply sealant to the threads of the mounting studs.

Description	Nm	lb-in.	lb-ft
Retainer bracket nuts	5.6	50	

Description	Where Used	Part Number
Loctite 242 Threadlocker	Fuel cooler mounting studs	92-809821

Installation

1. Place the cool fuel assembly on the engine mount studs. Install the two nuts.

Description	Nm	lb-in.	lb-ft
Engine mount studs nuts	41		30

2. Connect the fuel lines to the fuel filter adapter and tighten securely.

Description	Nm	lb-in.	lb-ft
Fuel lines	24		19

3. Connect fuel line to the fuel rail.
4. Connect vacuum line to intake manifold.
5. Attach engine harness electrical connector to fuel pump harness connector.
6. Clip fuel pump harness to cool fuel base.

⚠ CAUTION

Do not operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.

7. Connect seawater hoses to cool fuel system. Tighten hose clamps securely.
8. Unplug and connect seawater inlet hose. Open seacock, if equipped.
9. Unplug and connect fuel tank inlet line. Tighten hose clamp securely. Open fuel shut off valve, if equipped.

⚠ CAUTION

When installing battery, be sure to connect POSITIVE (+) battery cable to POSITIVE (+) battery terminal FIRST, and NEGATIVE (–) battery cable to NEGATIVE (–) battery terminal LAST. If battery cables are reversed, or connection order is reversed, electrical system damage will result.

10. Clean battery cable clamps and terminals and connect battery cables to the battery. Secure each cable clamp when connecting. Coat terminals with a battery terminal anti-corrosion spray to help retard corrosion.

⚠ WARNING

Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

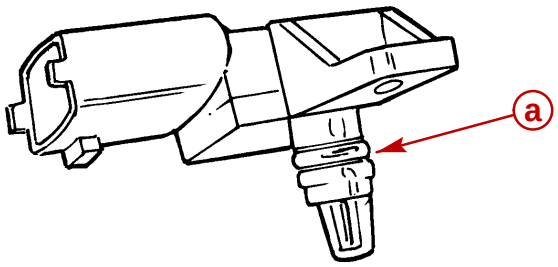
11. Start the engine; check for fuel and water leaks. Stop the engine immediately if any leaks exist. Make necessary corrections.
12. Install cool fuel system cover.

Sensors

Manifold Air Pressure / Temperature (MAPT) Sensor

REMOVAL

1. Disconnect the wiring harness connection from the MAPT.
2. Remove the MAPT and discard the seal.



78083

a - Seal

CLEANING AND INSPECTION

1. Clean the surfaces of the MAPT with a dry cloth.
2. Inspect the MAPT for signs of wear or damage.

INSTALLATION

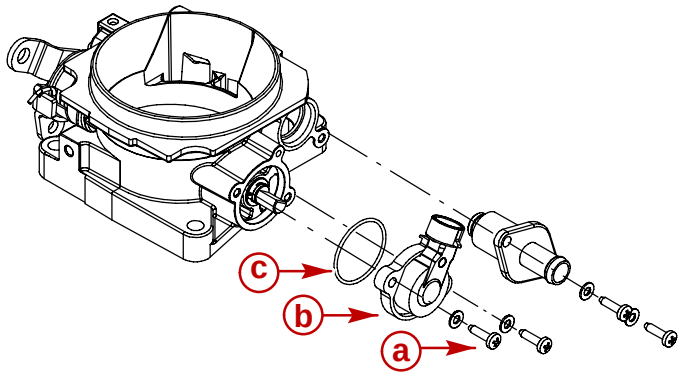
3. Install a new MAPT sensor seal onto the MAPT sensor.
4. Apply 1 drop of clean engine oil to the MAPT sensor seal.
5. Install the MAPT sensor into the upper intake manifold.

Description	Nm	lb-in.	lb-ft
Manifold air pressure and temperature sensor (MAPT)	6	53	

6. Connect electrical connector to the MAPT.

Throttle Position Sensor (TPS)

1. Remove the engine cover and flame arrestor.
2. Disconnect the harness connector from the TPS.
3. Remove the screws from the TPS.
4. Remove the TPS from the throttle body.



78124

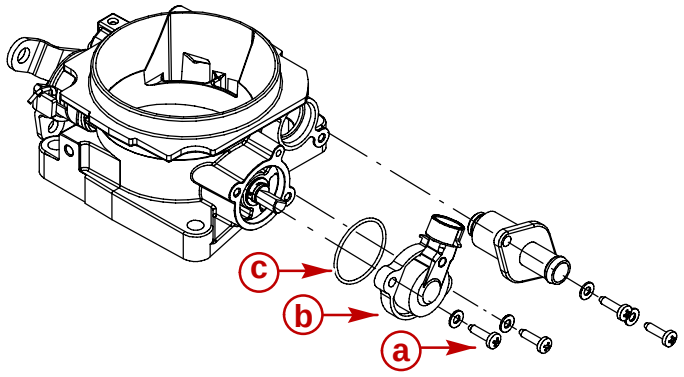
a - Screw (2)
b - Throttle position sensor
c - O-ring

CLEANING AND INSPECTION

1. Clean the surfaces of the TPS with a dry cloth.
2. Inspect the TPS for signs of wear or damage.

INSTALLATION

1. Apply adhesive to screw threads. Install the TPS on the intake manifold. Torque screws.



78124

Typical model

a - Screw (2)
b - Throttle position sensor
c - O-ring

Description	Where Used	Part Number
Loctite 242 Threadlocker	TPS screws	92-809821

Description	Nm	lb-in.	lb-ft
Throttle position sensor (TPS)	2	20	

2. Place a new sealing ring in the groove.
3. Install throttle body on the intake manifold. Torque nuts.

Description	Nm	lb-in.	lb-ft
Throttle body nuts	10	88	

4. Connect electrical connector to the TPS.
5. Install the flame arrestor.

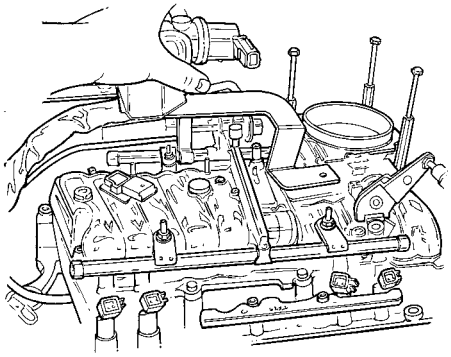
Description	Nm	lb-in.	lb-ft
Flame arrestor retainer bracket nut	12	108	

6. Install the engine cover.
7. When negative (–) battery cable has been reconnected, start engine and check for TPS output voltage. It should be approximately 0.7 volts at idle and 4.5 volts at wide open throttle.

Idle Air Control (IAC) Valve

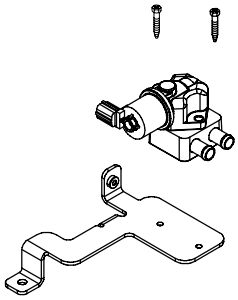
REMOVAL

1. Remove the engine cover.
2. Remove the IAC hoses.
3. Disconnect the electrical connector.
4. Remove the IAC bracket nuts.
5. Remove the IAC and bracket.



77999

6. Remove the 2 screws retaining the IAC to the bracket.



78088

INSTALLATION

1. Install IAC valve and bracket onto intake. Torque fasteners.

Description	Nm	lb-in.	lb-ft
IAC bracket nuts	15	132	
IAC to bracket bolts	19	168	

2. Connect electrical connector to IAC.

Knock Sensor

REMOVAL

1. Disconnect electrical connector at knock sensor located below the port valve cover on the rear of the engine.
2. Remove knock sensors from engine block.

CLEANING AND INSPECTION

1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

INSTALLATION

IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. Do not use sealer on threads.

1. Install knock sensor in engine block. Torque nut.

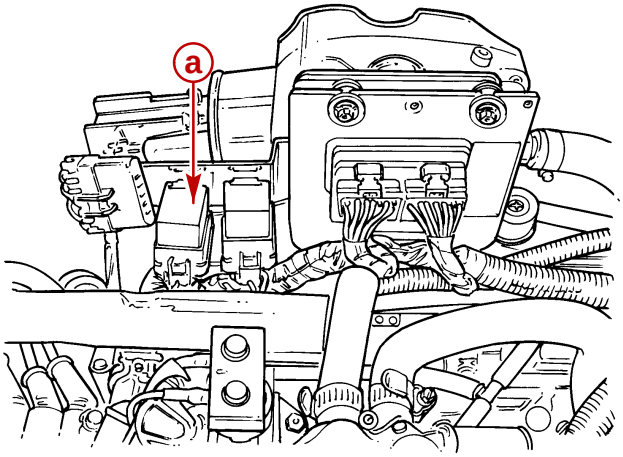
Description	Nm	lb-in.	lb-ft
Knock sensor nut	20		15

2. Connect electrical connector to knock sensor.

Fuel Pump Relay

REMOVAL

1. Remove fuel pump relay from electrical bracket.



77905

a - Fuel pump relay

2. Disconnect electrical connector and remove fuel pump relay.

CLEANING AND INSPECTION

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for signs of wear or physical damage.

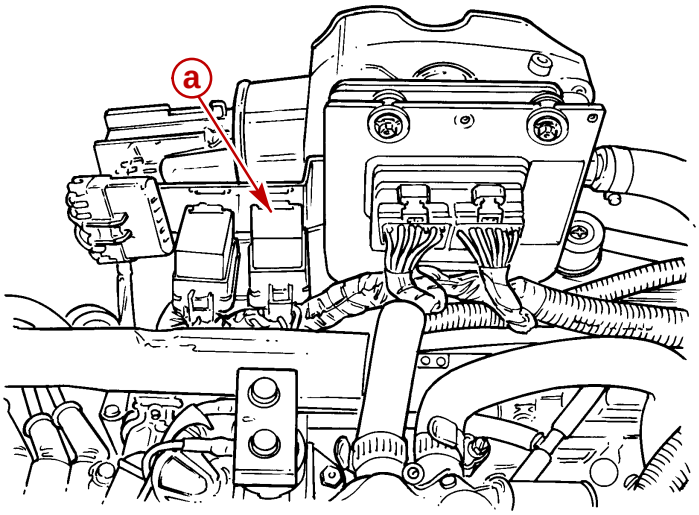
INSTALLATION

1. Connect the electrical connector to the relay.
2. Attach fuel pump relay to bracket.

Main Power Relay

REMOVAL

1. Remove the main power relay from electrical box.



77905

a - Main power relay

2. Disconnect the electrical connector and remove the relay.

CLEANING AND INSPECTION

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for evidence of damage.

INSTALLATION

1. Attach the electrical connector to the relay.
2. Attach the main power relay to the electrical bracket.

FUEL SYSTEM

Section 5C - Scorpion Fuel System

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5C

Specifications

Description	Specification
Fuel pump pressure	96.5 kPa (43 psi2)

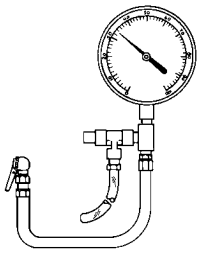
Torque Specifications

Description	Nm	lb-in.	lb-ft
Distributor hold down clamp bolt	24.4		18
Engine coolant temperature sensor (ECT)	20	180	
Flame arrestor nut	12	108	
Fuel inlet fitting	Finger tight + 1-3/4 to 2-1/4 turns with a wrench. Do NOT overtighten.		
Fuel lines	25.7		19
Fuel rail bracket bolt	5.9	53	
Fuel rail retainer nuts	3	27	
IAC bracket nuts	14.9	132	
IAC to bracket bolts	22.3	198	
IAC plug to throttle body screws	2.7	24	
Idle air control valve (IAC)	2.2	20	
Ignition coil studs	11.9	106	
Knock sensor to block	20	180	
Throttle body fasteners	8.5	75	

Torque Specifications (continued)

Description		Nm	lb-in.	lb-ft
Manifold air pressure sensor (MAP)		5.9	53	
Manifold air temperature sensor (MAT)				
Engine mount studs nuts		40.6		30
Fuel pressure regulator screws		5.9	53	
Retainer bracket nuts		5.6	50	
Stepped screw		9.1	81	
Throttle cable bracket nuts		18.9	168	
Throttle position sensor (TPS)		2.2	20	
intake manifold bolts				
	First pass	4.9	44	
	Final pass	10	89	
IAC screw 1/4-20 x 25 mm (1 in.) long		10.8	96	
Plenum screw		10.8	96	
Plenum nut		10.8	96	
Knock sensor nut		20	180	
Fuel inlet fitting (boost pump)		23-31		17-23
Fuel filter base bracket-to-engine mount stud locknut		48-54		35-40
Fuel filter base-to-bracket locknut		23-31		17-23
Boost pump flange head brace-to-cylinder block screw		48-54		35-40
Fuel line		20-28.5		15-21

Special Tools

Fuel Pressure Gauge Kit		
 73814	Use to test the fuel pump pressure, includes: 91-803135 fuel pressure adapter kit 91-806901 fuel pressure tee 91-881833A1 160 psi gauge	91-881833A2

Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Thermal Grease	Cool fuel retainer bracket	Obtain locally
Loctite 242	Throttle body studs, fuel cooler mounting studs, lower intake manifold bolts	92-809821
Loctite 565	Fuel fittings	Obtain locally
Engine oil	Filter sealing ring	Obtain locally
Loctite 5900 Ultra Black RTV Silicone Sealant	Lower intake manifold gaskets, engine block at lower intake manifold sealing surfaces	92-809826

Replacement Parts Warning

Use of parts other than the recommended service replacement parts will void the warranty on those parts that are damaged as a result.

⚠ WARNING

Electrical, ignition and fuel system components on Mercury MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Abbreviations

amp	Amperes	in. hg	Inches Of Mercury
BARO	Barometric Pressure	INJ	Injector
Bat	Battery Positive Terminal, Battery or System Voltage	kPa	Kilopascal
B+	Battery Positive Voltage	KS	Knock Sensor System
Bps	Beeps	kV	Kilovolts
CAM	Camshaft	mA	milliamperes
cond	Condition	MPR	Main Power Relay
cont	Continuous	MAP	Manifold Air Pressure
Crank	Crankshaft	MAT	Manifold Air Temperature
CAN	Control Area Network	mohms	Milliohms
CKT	Circuit	mSec	Millisecond
CMP	Camshaft Position Sensor	N/C	Normally Closed
Conn	Connector	N/O	Normally Open
CPS	Crankshaft Position Sensor	OBD	On-Board Diagnostic Test
Cyl	Cylinder	PCM	Propulsion Control Module
DDT	Digital Diagnostic Terminal	RAM	Random Access Memory
Deg	Degrees	REF HI	Reference High
Diag	Diagnostic	REF LO	Reference Low
DIS	Distributorless Ignition System	RFI	Resistance Frequency Interval
DLC	Data Link Connector	ROM	Read Only Memory
Dtc	Diagnostic Trouble Code	RPM	Revolutions per Minute
DMM DMT DVOM	Digital Multimeter	SW	Switch
ECM	Electronic Control Module	TACH	Tachometer
ECT	Engine Coolant Temperature	TERM	Terminal
EFI	Electronic Fuel Injector	TPS	Throttle Position Sensor
EMCT	Exhaust Manifold Coolant Temperature	V	Volts
EST	Electronic Spark Timing	VAC	Vacuum
GND	Ground	VDC	Volt Direct Current
IAC	Idle Air Control	VOA	Volt/Ohm/Amp Meter
IGN	Ignition	WOT	Wide Open Throttle

Precautions

⚠ WARNING

Avoid personal injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

⚠ WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. Do NOT smoke or allow sources of spark or flame in the area while changing fuel filters. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure that no fuel leaks exist before closing engine hatch.

⚠ CAUTION

Do NOT operate engine without cooling water being supplied to seawater pickup pump or pump impeller will be damaged and subsequent overheating damage may result.

⚠ WARNING

Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

Fuel Supply Connections

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

IMPORTANT: The following information is provided to ensure proper installation of brass fittings or plugs installed into fuel pump or fuel filter base:

- **Use Loctite 565 Pipe Sealant with Teflon on threads of fuel inlet fittings or plugs. DO not USE TEFLON TAPE.**
- **Fuel inlet fittings or plugs should first be threaded into fuel pump or fuel filter base until finger-tight.**
- **Fuel inlet fittings or plugs should then be tightened an additional 1-3/4 to 2-1/4 turns using a wrench. DO not OVERTIGHTEN.**
- **To prevent overtightening when installing a fuel line, the brass fittings should be held with a suitable wrench as fuel inlet fittings are tightened securely.**

Fuel Delivery System

Recommendations

NOTE: On Ski Boat Applications: *If during testing for a particular application, you experience fuel starvation in sharp high speed turns, baffles or a fuel sump may be needed in the tank to help correct this condition.*

⚠ WARNING

Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when constructing the engine compartment.

The main concern of a boat's fuel system is safety; this must be achieved through a technically sound installation and constant inspection.

The fuel system, from the filler pipe to the fuel pump, is the same in principle for all boats.

The fuel tank is an integrated component of the boat. Refer to the special information on service and maintenance, which you have received from the tank manufacturer.

Only a few points related to function and safety are listed here [Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines]:

- All connections should be on the upper side of the tank.
- The drain plug at the lowest point on the tank serves to permit the removal of water and sediment.
- The tank breather pipe must have an inner diameter of at least 13 mm (1/2 in.) and must be fitted with a swan neck to prevent water from entering the tank.

It is recommended that the exact route and length of the fuel lines be established at the first installation of the engine to prevent problems later in connecting them to the engine.

All fuel lines must be well secured. The holes where the lines run through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

The following, but not limited to the following, additional fuel connection related points, *applying to all engines unless otherwise stated*, must be considered [Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines]:

1. Fuel pickup should be at least 25 mm (1 in.) from the bottom of fuel tank to prevent picking up impurities.
2. The maximum measured vacuum at the engine's fuel inlet must not exceed 6.9 kPa (2 in. Hg) at 600, 3000, full throttle rpm, and idle rpm.

IMPORTANT: Use an accurate digital vacuum gauge that reads in either in. Hg (inches of Mercury) or (kPa) to check this specification. Common vacuum gauges used to check engine intake manifold vacuum are not accurate enough to make this type of measurement. The recommended gauge is the Cole-Parmer Digital Compound Gauge (30 in. Hg to 99.9 psi) that has an accuracy of within 2% of the reading. The part number is P-68950-00.

IMPORTANT: Vacuum reading higher than specified can cause vapor locking with some of today's fuels. It can also cause poor engine performance because of fuel starvation.

3. Fuel lines used must be Coast Guard approved (USCG Type A1).

Description	Specification
Inside diameter of fittings and lines	10 mm (3/8 in.)

4. **On Multi-Engine Gasoline Installations:** It is best to use a fuel pickup and supply line for **each** engine. If a single pickup and line is used, line must be 13 mm (1/2 in.) ID or larger.
5. Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
6. Fuel lines should be installed free of stress and firmly secured to prevent vibration and/or chafing.
7. Sharp bends in fuel lines should be avoided.
8. A flexible fuel line must be used to connect fuel supply line to fuel inlet fitting on engine to absorb deflection when engine is running.

Measuring Vacuum

IMPORTANT: Use an accurate digital vacuum gauge that reads in either in. Hg (inches of Mercury) or (kPa) to check this specification. Common vacuum gauges used to check engine intake manifold vacuum are not accurate enough to make this type of measurement. The recommended gauge is the Cole-Parmer Digital Compound Gauge (30 in. Hg to 99.9 psi) that has an accuracy of within 2% of the reading. The part number is P-68950-00.

1. Using a 1/8 in. pipe thread (female, for gauge) to 1/4 in. pipe thread (male, for Gauge Guard), install the O–ring and thread the adapter into the Gauge Guard.

NOTE: *Some Gauge Guards may have 1/2 in. pipe thread.*

2. Turn the gauge and Gauge Guard upside down and fill them both with the specified fluid.
3. Use a small, blunt-tipped (not sharp) object that fits into the opposite side of the Gauge Guard to push up the diaphragm and push out some fluid about 1/8 in. (3 mm). If this is not done, when you thread the gauge into the Gauge Guard, you will create pressure that the adjustment screw on the gauge.

NOTE: *If there is any air in the system, this will effect the accuracy of the reading you take with this gauge.*

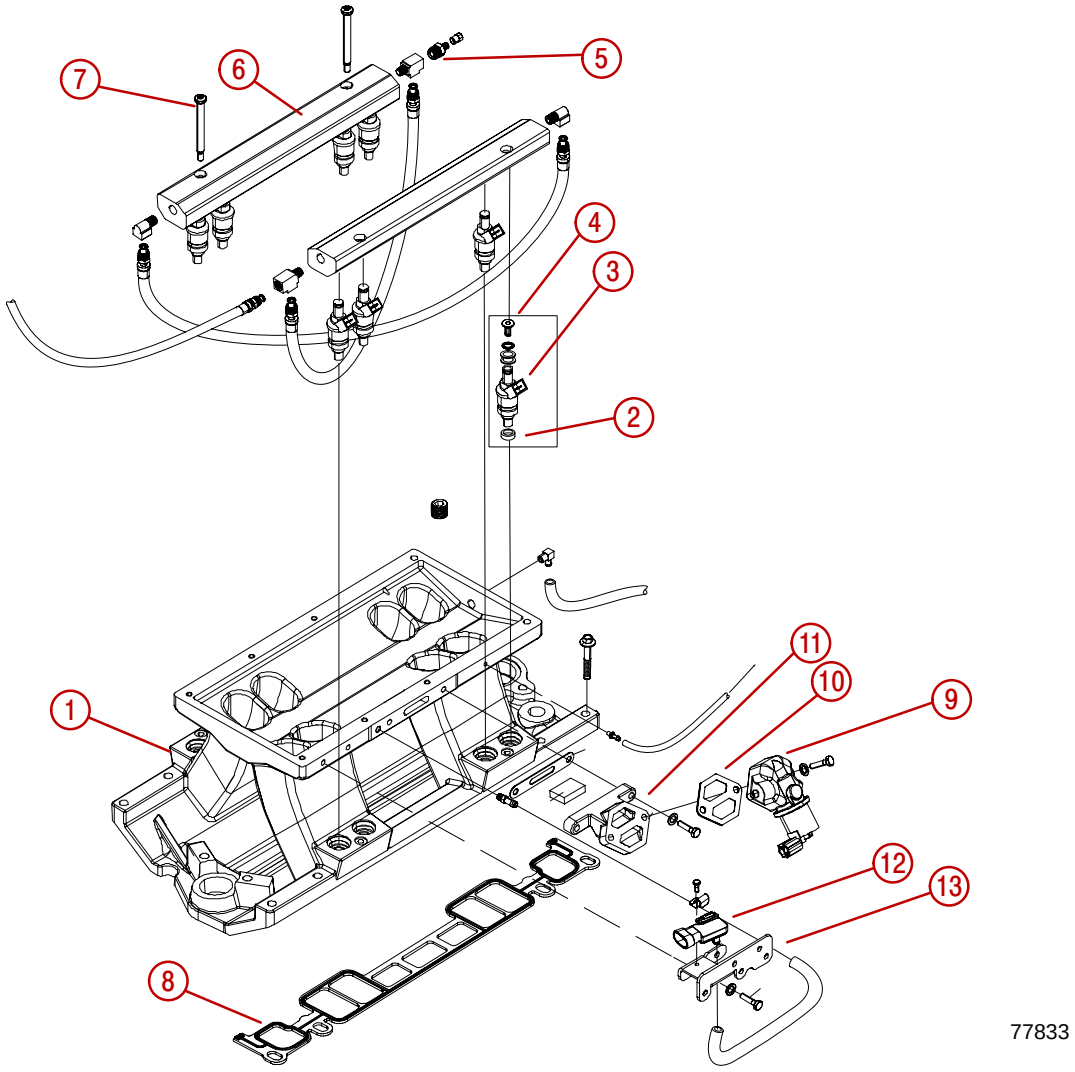
4. Quickly turn the gauge over and thread it into the Gauge Guard.

Anti-Siphon Valve

U.S. boating standards and regulations specify that an anti-siphon valve be used on any application where any portion of the fuel line falls below the top of the fuel tank. This valve serves to minimize the amount of fuel that could leak into the bilge of the boat in the event of a fuel system leak. A mechanical anti-siphon valve or an electrically operated fuel shut-off valve is acceptable for this purpose and should be installed in accordance with industry standards and the manufacturer’s instructions. The mechanical valve must be carefully sized to the fuel pressure head produced in a given application (a function of the fuel level height between the lowest and highest point in the system). The valve must check the flow of fuel when the engine is not running, yet avoid excessive restriction when the engine is operating. An overall fuel system pressure drop of 6.9 kPa (1 psi) or less is desirable but may not be achievable in all cases. In these cases, it is recommended that an electric fuel shut-off valve be used.

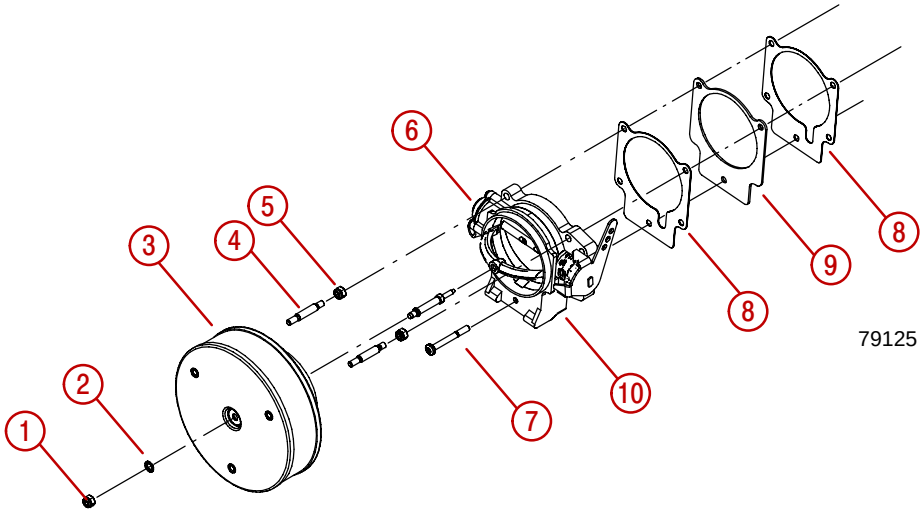
Exploded Views

Fuel Rail and Injectors



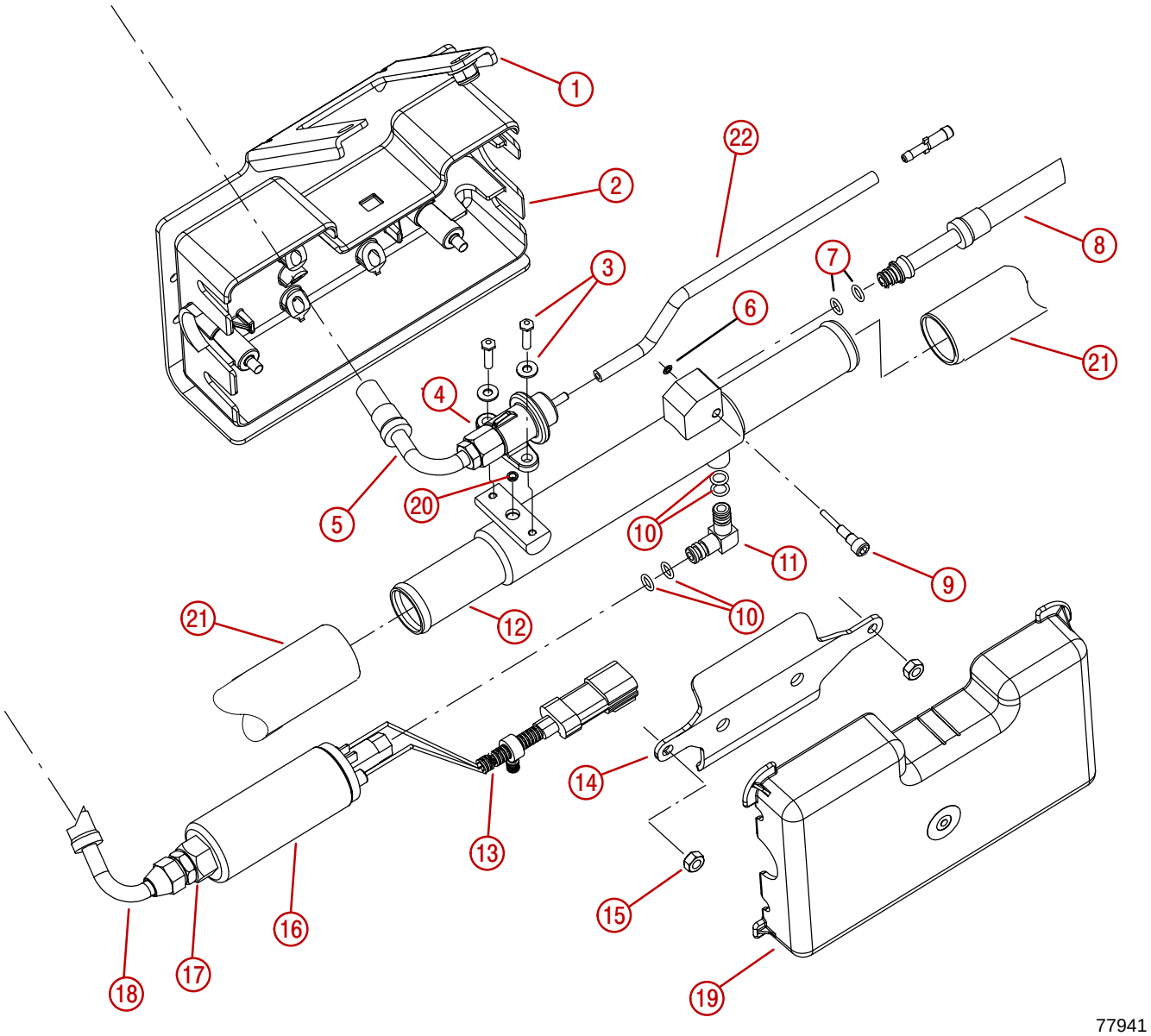
1 - Intake manifold
2 - O-rings (8)
3 - Fuel injectors (8)
4 - Fuel injector retainer clip
5 - Schrader valve (fuel pressure relief)
6 - Fuel rail
7 - Fuel rail bolts
8 - Intake manifold gasket
9 - IAC
10 - IAC gasket
11 - IAC bracket
12 - MAP sensor
13 - MAP bracket

Throttle Body



1 - Nut
2 - Washer
3 - Flame arrestor
4 - Stud
5 - Nut (2)
6 - Throttle position sensor
7 - Bolt
8 - Throttle body gasket
9 - Throttle body adapter
10 - Throttle body

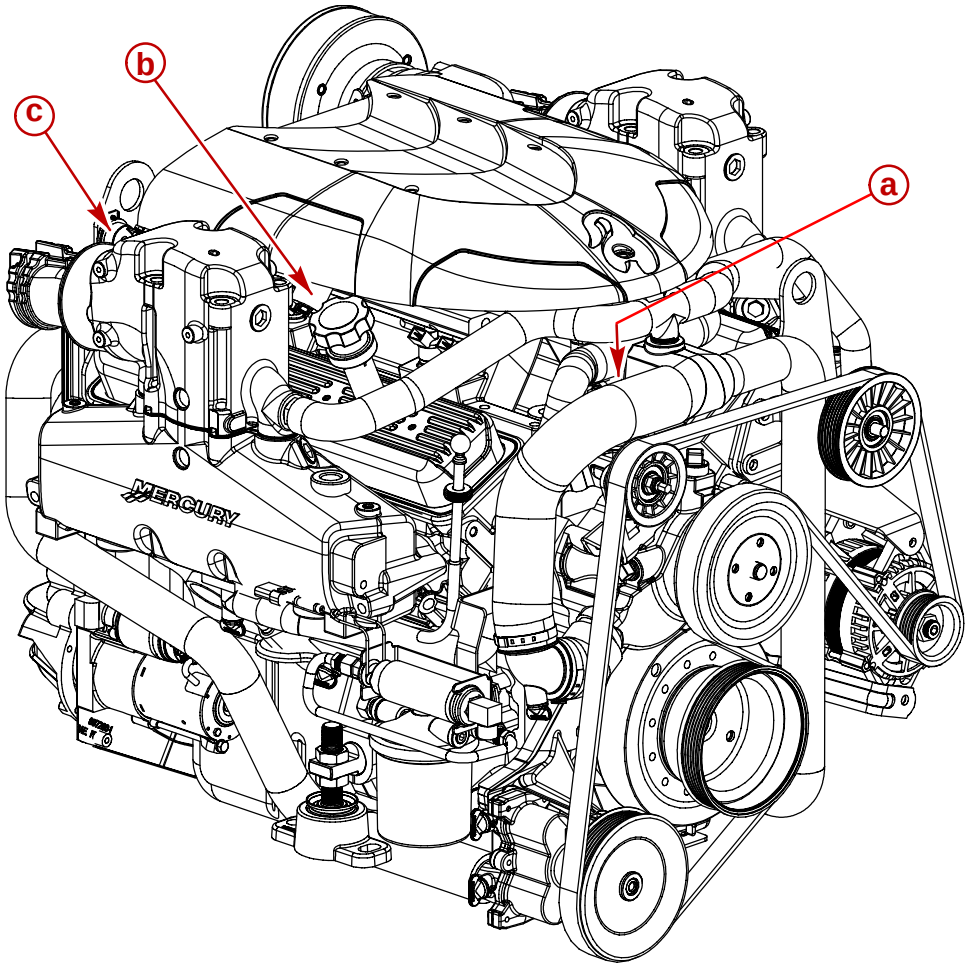
Cool Fuel System



77941

1 - Bracket
2 - Cover base
3 - Screw and washer (2)
4 - Fuel pressure regulator
5 - Return fuel line
6 - Retaining ring
7 - O-rings (2)
8 - Fuel line, fuel pump-to-fuel rail
9 - Stepped screw
10 - O-rings (4)
11 - Elbow fitting
12 - Fuel cooler
13 - Fuel pump wiring harness
14 - Retainer bracket
15 - Nut (2)
16 - Electric fuel pump
17 - Inlet fitting
18 - Fuel line inlet
19 - Cover
20 - Filter
21 - Seawater hoses (hose clamps not shown)
22 - Vacuum hose

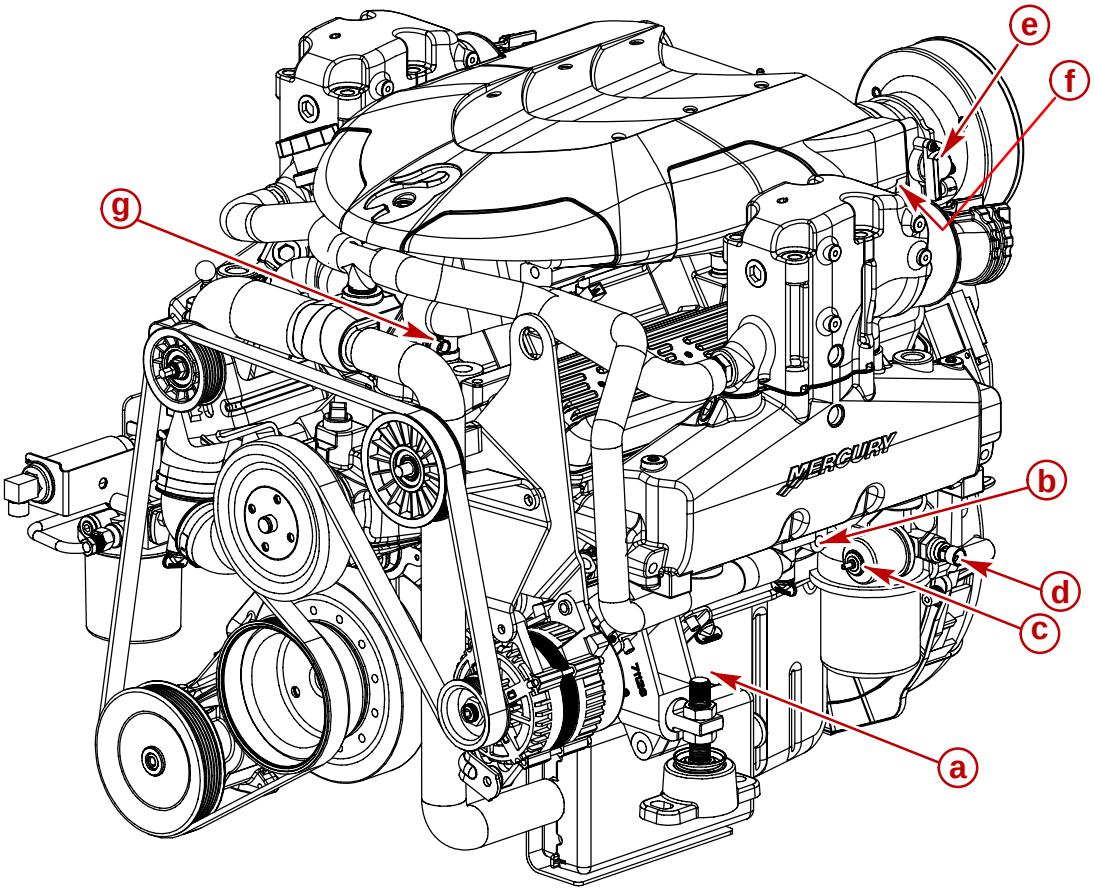
Sensor Locations



79142

a - Water temperature sender
b - Idle air control (IAC) valve
c - Circuit breaker

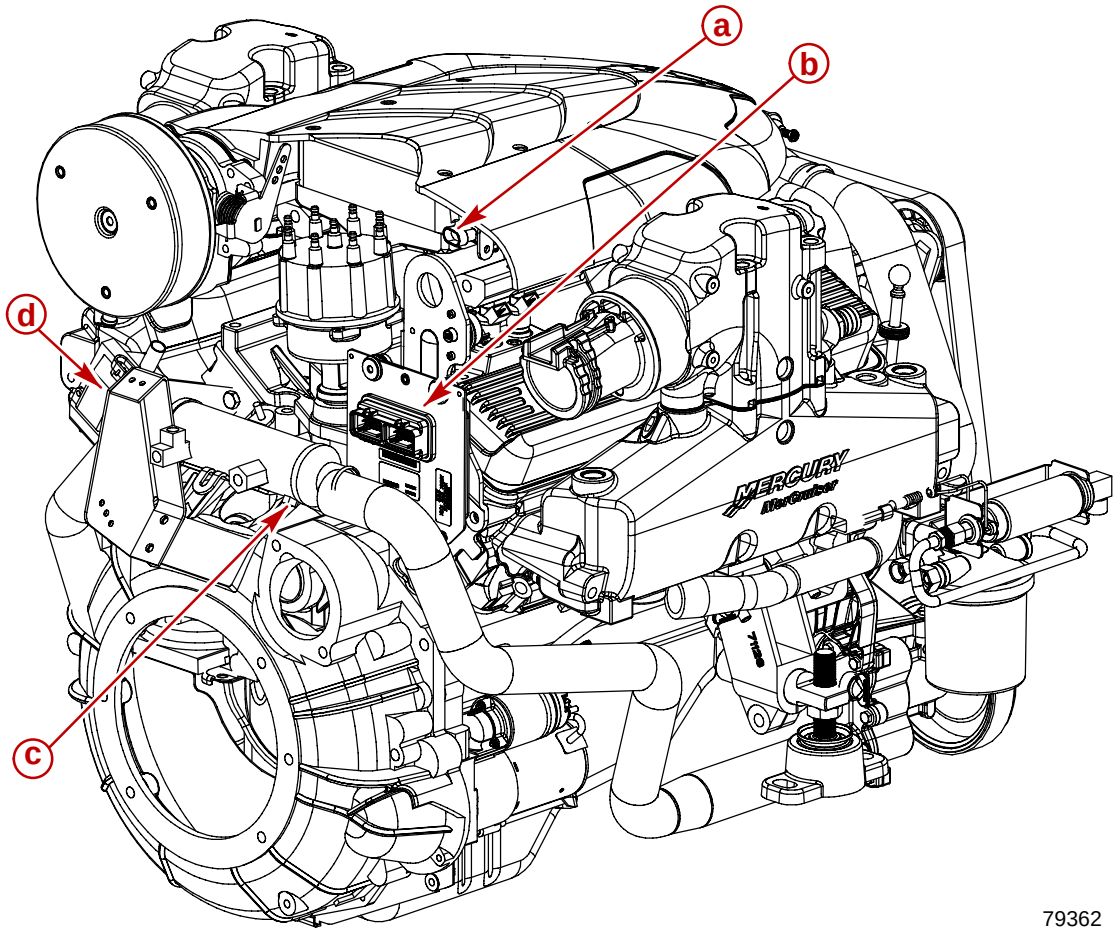
Sensor Locations (continued)



79143

a - Cool fuel harness connector (not shown)
b - Knock sensor location
c - Oil pressure sender
d - Oil pressure sensor
e - Throttle position sensor (TPS)
f - Manifold air temperature (MAT) sensor
g - Coolant temperature sensor (CTS)

Sensor Locations (continued)



79362

a - Manifold air pressure (MAP) sensor
b - Electronic control module (ECM)
c - Water pressure sender
d - Ignition coil

Fuel Pressure Relief Procedure

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

⚠ WARNING

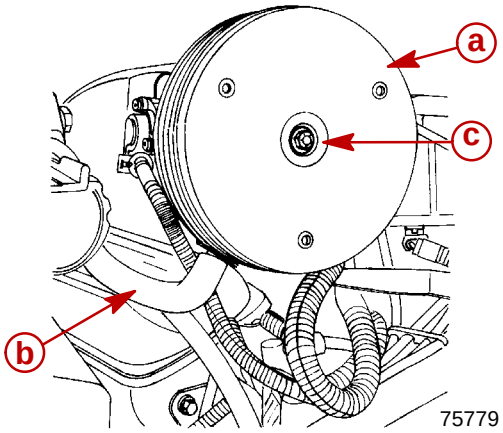
Avoid Fire or Explosion: The fuel injection system is pressurized during operation. Use care when removing the water separating fuel filter. Fuel could spray on the hot engine causing fire or explosion. Allow the engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.

1. Activate the Schrader valve located on the fuel rail to release pressure.

Flame Arrestor

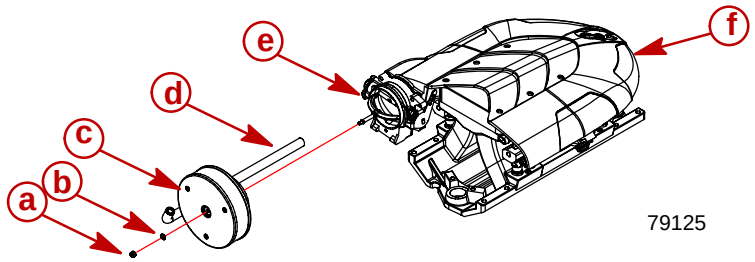
Removal

1. Remove nut and washer.



a - Flame arrestor
b - Vent hose
c - Nut

2. Remove crankcase ventilation hose from against flame arrestor and rocker arm cover fittings.
3. Remove flame arrestor.



a - Nut
b - Washer
c - Flame arrestor
d - Crankcase ventilation system
e - Throttle body
f - Plenum

Cleaning and Inspection

1. Clean flame arrestor and crankcase ventilation hoses in steam or water.
2. Wear eye protection. Dry parts with compressed air.
3. Inspect crankcase ventilation hoses for cracks or deterioration and replace if necessary.
4. Clean and inspect the IAC filter and replace the IAC gasket.

Installation

1. Install the flame arrestor on the throttle body.
2. Install the washer and nut and torque.

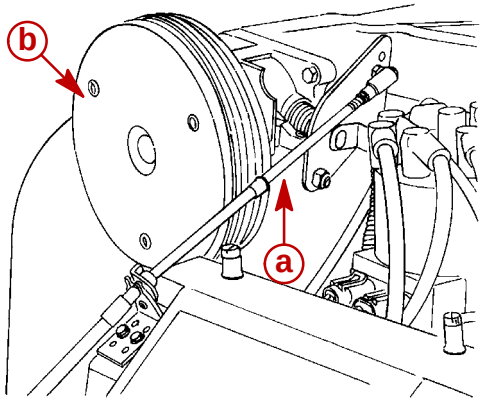
Description	Nm	lb-in.	lb-ft
Flame arrestor nut	12	108	

3. Install the crankcase ventilation hoses.

Throttle Body

Removal

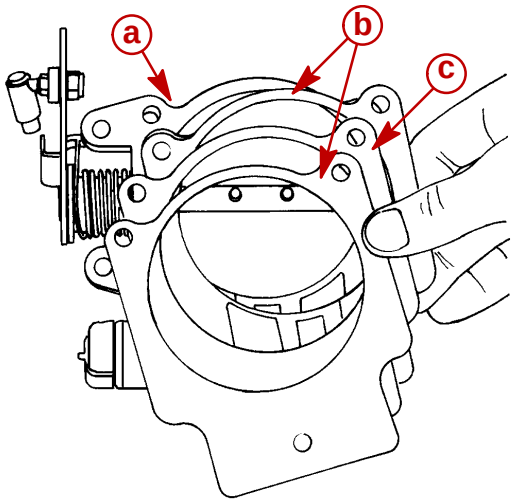
1. Remove the flame arrestor.
2. Disconnect the throttle cable from the throttle lever.



74838

a - Throttle cable
b - Flame arrestor

3. Disconnect the wiring connectors from the IAC valve and the TP sensor.
4. Remove the hardware retaining the throttle body and remove the throttle body from the adapter. Refer to Exploded View.



75783

a - Throttle Body
b - Gaskets
c - Plate

IMPORTANT: Insert a clean shop towel into the opening of the plenum to prevent foreign material from entering the engine.

Cleaning and Inspection

IMPORTANT: Do not use cleaners containing methyl ethyl ketone.

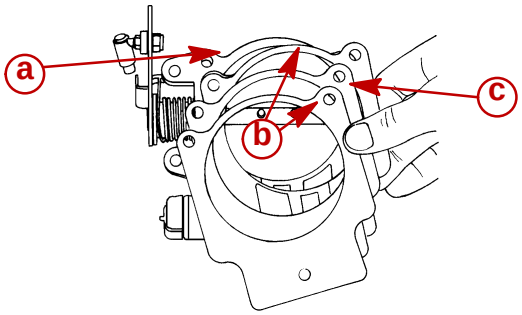
IMPORTANT: Do not get solvent or cleaner on the TPS.

IMPORTANT: Do not damage the adapter and throttle body when removing gasket material from adapter and throttle body.

1. Carefully remove all gasket material from adapter and throttle body.
2. Thoroughly clean all parts of throttle body. Ensure that all passages are free of dirt and burrs.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect throttle body for cracks in casting.
5. Inspect throttle plates, linkage, return springs and other components for damage, wear, and foreign material.

Installation

1. Place the throttle body gaskets and adapter between the throttle body and the plenum.

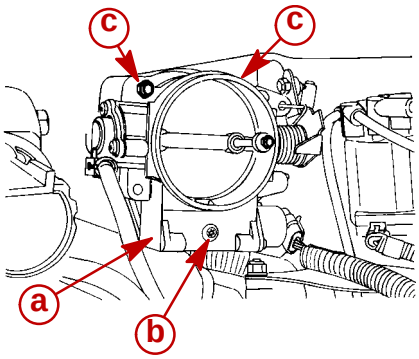


75783

a - Throttle body
b - Gaskets
c - Adapter

2. Place the throttle body on the plenum.

3. Install the screw and nuts and torque.



75781

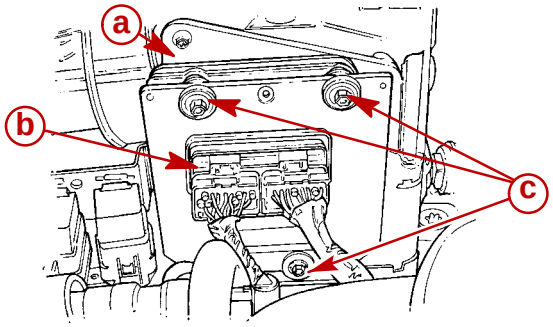
a - Throttle body
b - Screw
c - Nuts

Description	Nm	lb-in.	lb-ft
Throttle body fasteners	8.5	75	

4. Connect the harness connector to the TPS.
5. Connect the throttle cable to the throttle lever. Refer to SECTION 2 for throttle cable adjustment.
6. Install the flame arrestor.

Electronic Control Module (ECM)

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. Do NOT touch connector pins when removing or installing the module.

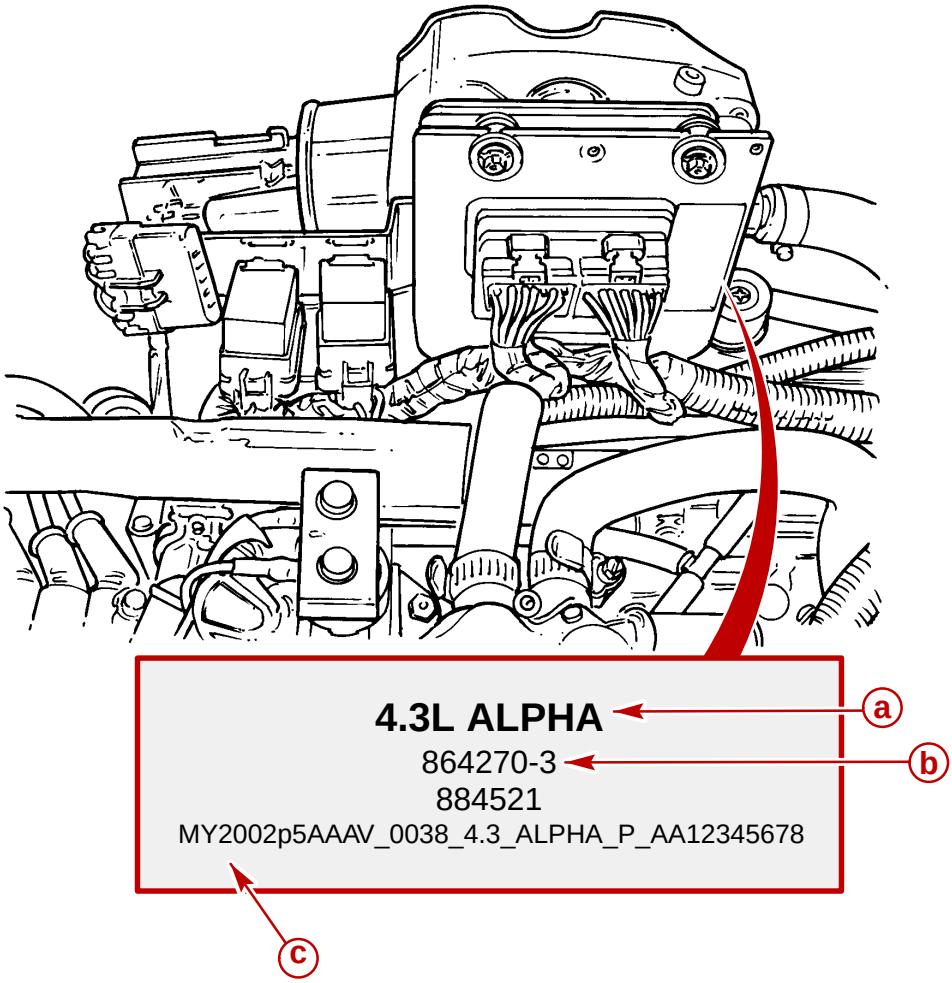


78019

a - ECM bracket
b - Electrical connectors
c - Fasteners

ECM Calibration Label

An ECM can be readily identified by the two wire harness connectors (A–B).



Typical ECM Calibration Label

- **a** - Engine Model
- **b** - Calibration Part Number
- **c** - Model Year

The ECM Calibration label includes the information necessary to determine the calibration that an engine is equipped with from the factory. The top line is the engine model designation. It is important that Alpha ECM's are only used on Alpha models, Bravo ECM's are only used on Bravo models and Inboard ECM's are used only inboard models. The second line specifies the simple calibration number and version. In this case it is calibration 864270, version 3. The bottom line lists the model year of the ECM, in this case 2002, followed by detailed identification numbers of the exact calibration. Ensure that you have this information before calling Customer Service.

Removal

1. Disconnect the electrical connectors at the ECM. Do NOT touch the connector pins.
2. Remove the ECM from the electrical bracket.

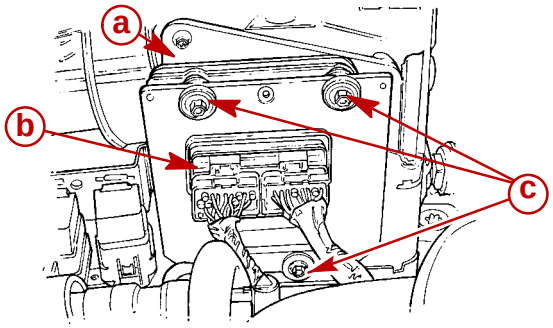
Cleaning and Inspection

1. Clean the exterior of the ECM with a dry cloth. Do NOT touch the connector pins.
2. Inspect outer surfaces for any obvious damage.
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect the connectors on the wiring harness for corrosion and terminals that may have loose connections.

NOTE: *The ECM is a sealed electrical component. If it is defective, replace the ECM.*

Installation

1. Mount the ECM to electrical bracket using screws and washers.
2. Connect the electrical connectors to the ECM. Do NOT touch the connector pins.



78019

a - ECM bracket
b - Electrical connectors
c - Fasteners

Boost Pump

Removal

⚠ WARNING

Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

NOTE: *Retain all fasteners and hardware unless instructed otherwise.*

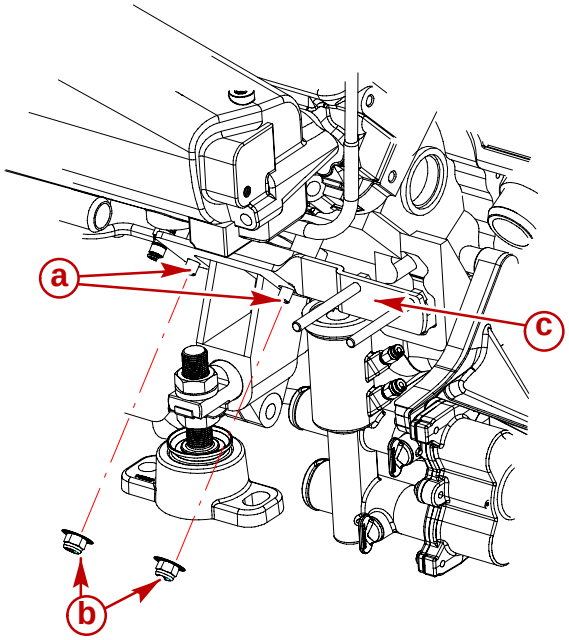
1. Disconnect both battery cables from the battery.

IMPORTANT: Plug the open ends of fuel line connections to prevent fuel leaks and entry of water or contaminates into lines while working.

2. Disconnect and plug the fuel line from the fuel inlet fitting.
3. Remove the locknuts and disconnect the electrical connector.
4. Remove the fuel pump.
5. Remove the water separating fuel filter.
6. Remove the insulator plate and fuel filter bracket.

Installation

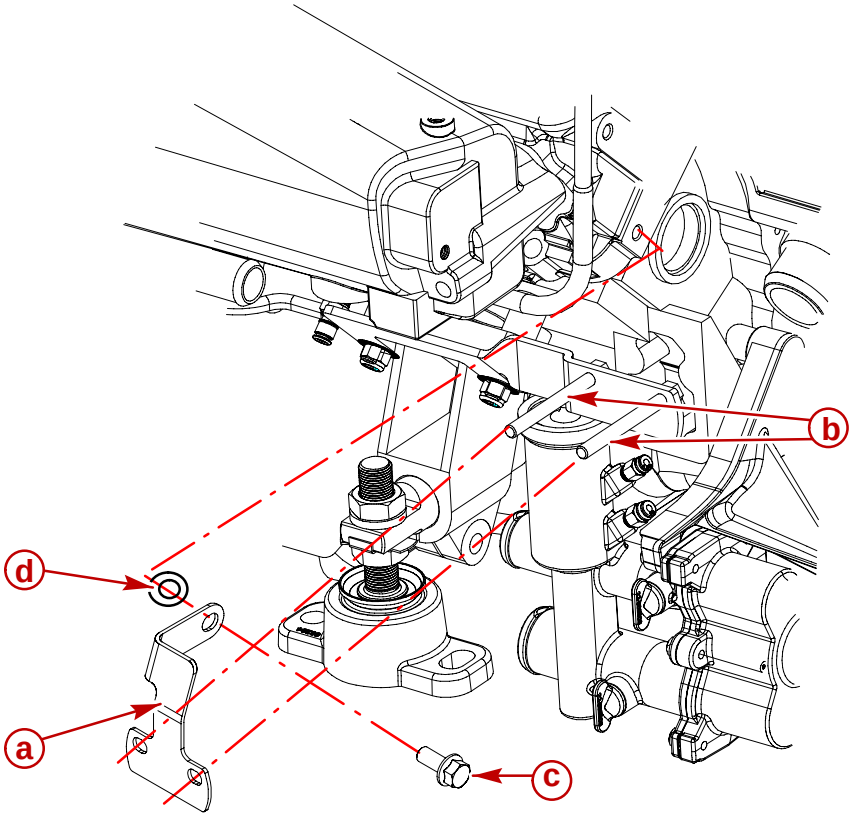
1. Place the fuel filter base bracket on the engine mount studs.
2. Install the two locknuts. Do NOT tighten at this time.



78452

a - Engine mount studs
b - Locknuts
c - Fuel filter base bracket

3. Place the fuel filter brace onto the fuel filter base bracket studs.

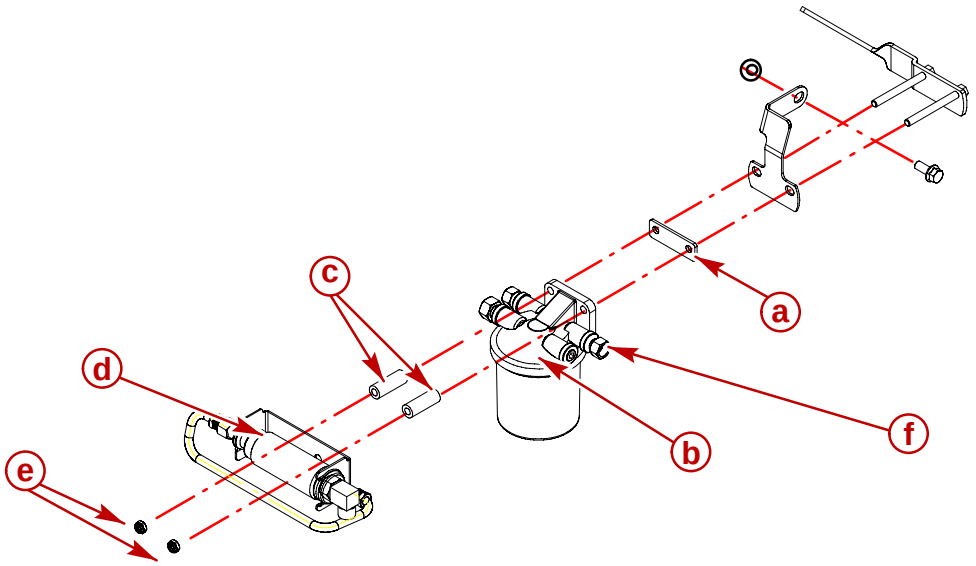


78452

a - Fuel filter brace
b - Bracket studs
c - Screw
d - Spacer

4. Fasten the brace to the cylinder head using the screw and the spacer. Ensure that the spacer is placed between the brace and the cylinder head. Do NOT tighten at this time.

NOTE: *Ensure that the existing vent tube and harness wire are not trapped between the brace and the cylinder head.*

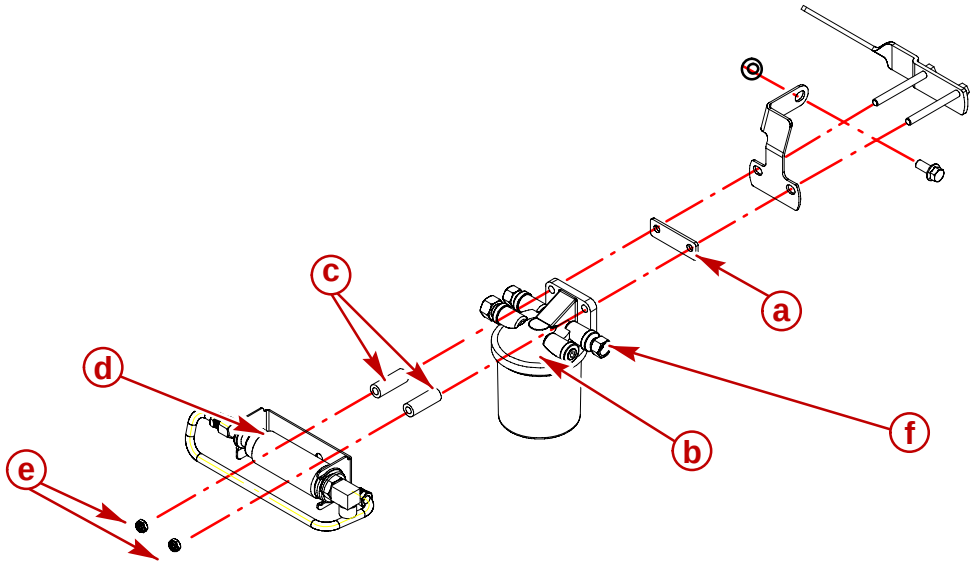


78454

a - Insulator plate
b - Fuel filter base
c - Collars
d - Boost pump assembly
e - Locknuts
f - Fuel inlet fitting

5. Install the insulator plate and the fuel filter base on bracket studs.
6. Install one collar on each of the bracket studs.
7. Install the boost pump assembly on the bracket studs.
8. Install the two locknuts. Do not tighten at this time.

9. Connect the boost pump fuel line to the fuel base inlet fitting. Do not tighten at this time.



78454

a - Insulator plate
b - Fuel filter base
c - Collars
d - Boost pump assembly
e - Locknuts
f - Fuel inlet fitting

10. Torque the two locknuts securing the fuel filter base bracket to the engine mount studs.

Description	Nm	lb-in.	lb-ft
Fuel filter base bracket-to-engine mount stud locknut	48-54		35-40

11. Torque the screw securing the filter brace to the cylinder head.

Description	Nm	lb-in.	lb-ft
Flange head brace-to-cylinder block screw	48-54		35-40

12. Torque the two locknuts securing the boost pump bracket.

Description	Nm	lb-in.	lb-ft
Fuel filter base-to-bracket locknut	23-31		17-23

13. Torque the boost pump fuel line fitting.

Description	Nm	lb-in.	lb-ft
Fuel line fitting	20-28.5		15-21

14. Connect the harness assembly to the harness connector on the cool fuel box and the engine harness connector.
15. Route the harness assembly along the lower port side of the engine to the rear of the engine and along the lower starboard side of the engine.
16. Connect the harness assembly connector to the harness connector on the boost pump.
17. Install the in-line fuel filter. Refer to the instructions included in the fuel filter assembly.
18. Reconnect both battery cables to the battery.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

19. Supply cooling water to the engine.

⚠ WARNING

Make sure that no fuel leaks exist before closing engine hatch.

20. Start engine and check for leaks.

In-line Fuel Filter

Removal

⚠ WARNING

Be careful when changing the fuel filter. Gasoline is extremely flammable and highly explosive under certain conditions. Ensure that the ignition key is OFF. Do not smoke or allow spark or open flame in the area when changing the fuel filter. Wipe up any spilled fuel immediately.

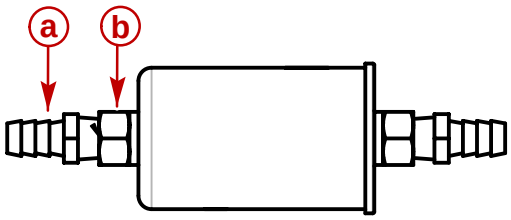
1. Verify the presence of an anti-siphon valve. If no anti-siphon valve is present, plug fuel line from the fuel tank.
2. Remove the existing in-line fuel filter.

Installation

1. Select appropriate size connector for the fuel line and install the connector on the filter.
2. Apply sealant to the male pipe threads on the connectors.

Description	Where Used	Part Number
Loctite 565	Male threads	Obtain locally

3. Torque each connector using a backup wrench on the hex fitting nearest to the connector.

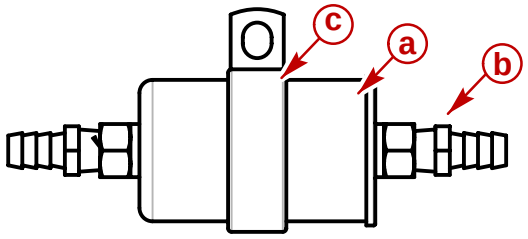


78289

a - Connector
b - Hex fitting

Description	Nm	lb-in.	lb-ft
Connectors	19-27		14-20

4. Insert filter into the mounting clip.



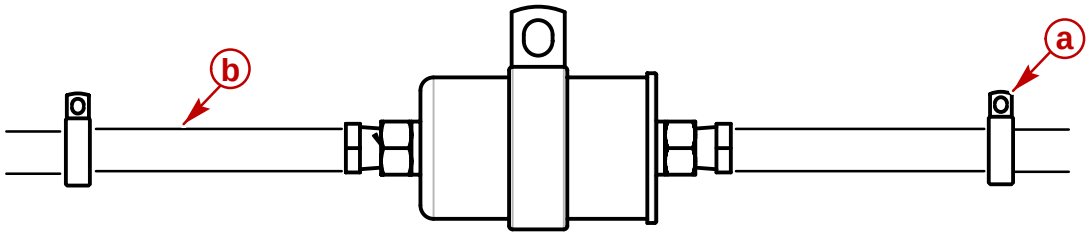
78289

a - In-line filter
b - Connectors
c - Mounting clip

5. Install and torque screw and washer through the mounting clip into the stringer.

Description	Nm	lb-in.	lb-ft
Mounting clip screw	12.2		9

6. Insert the hoses onto the barb fittings and fasten using hose clamps.



78289

a - Fuel line stringer clips
b - Fuel line

Description	Nm	lb-in.	lb-ft
Hose clamps	3.4-6.8	30-60	

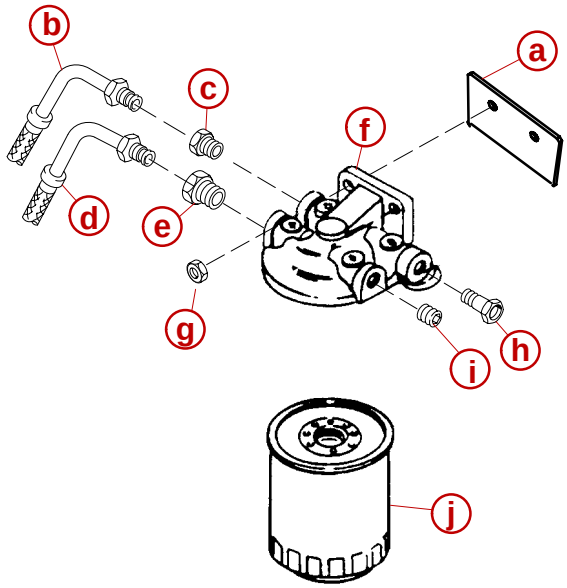
Water Separating Fuel Filter

⚠ WARNING

Avoid Fire or Explosion: The fuel injection system is pressurized during operation. Use care when removing the water separating fuel filter. Fuel could spray on the hot engine causing fire or explosion. Allow the engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.

⚠ WARNING

Be careful when changing the water separating fuel filter. Gasoline is extremely flammable and highly explosive under certain conditions. Ensure the ignition key is OFF. Do not smoke or allow spark or open flame in the area when changing the fuel filter. Wipe up any spilled fuel immediately.



78131

a - Insulator plate
b - Fuel return line from regulator
c - Brass fitting
d - Fuel line to fuel pump
e - Brass fitting
f - Fuel filter mounting bracket
g - Nut
h - Fuel inlet fitting
i - Plug
j - Water separating fuel filter

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Allow the engine to cool down.

NOTE: *Mercury MerCruiser recommends that the engine be shut off for 12 hours prior to filter removal.*

2. Disconnect both battery cables from the battery.
3. Activate the Schrader valve to relieve fuel pressure.

⚠ WARNING

Avoid Fire or Explosion: The fuel injection system is pressurized during operation. Use care when removing the water separating fuel filter. Fuel could spray on the hot engine causing fire or explosion. Allow the engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.

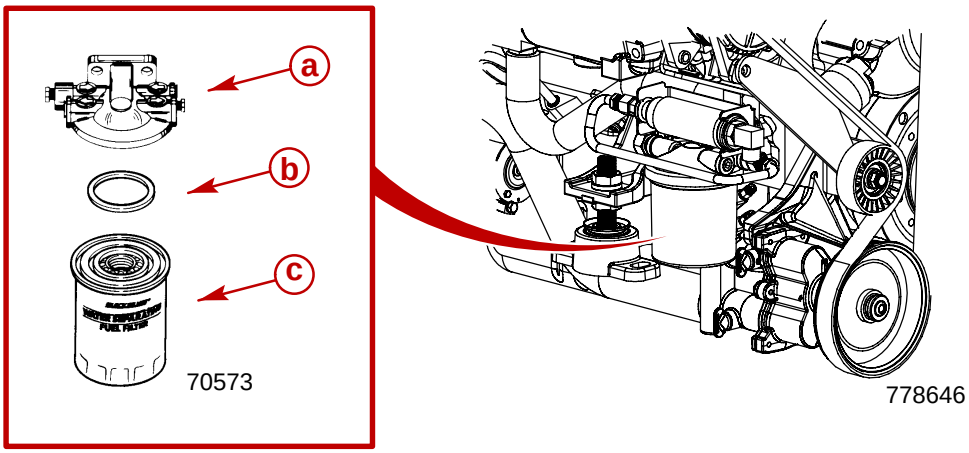
4. Wrap the water separating fuel filter with a cloth to help catch any fuel spills or spray.
5. Remove and discard the water separating fuel filter and sealing ring from the mounting bracket.

Installation

1. Lubricate sealing ring of new filter with engine oil.

Description	Where Used	Part Number
Engine Oil	Filter Sealing Ring	Obtain locally

2. Install a new filter. Tighten securely by hand.



a - Fuel filter base
b - Sealing ring
c - Fuel filter

3. Connect both battery cables to the battery.
4. Supply water to cooling system.

⚠ WARNING

Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

5. Start engine.

⚠ WARNING

Ensure that no fuel leaks exist before closing the engine hatch.

6. Check for fuel leaks.

Cool Fuel System

Removal

⚠ WARNING

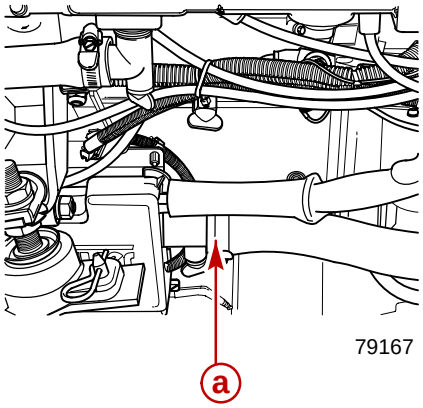
Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

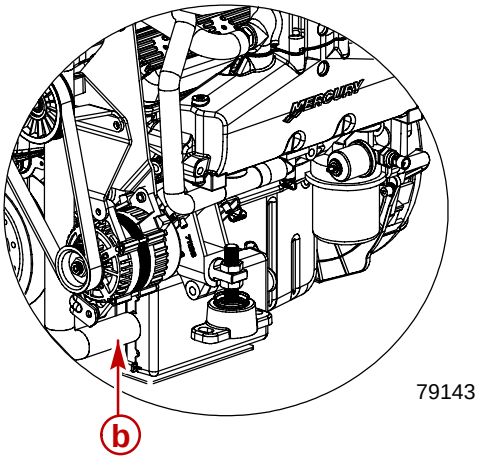
1. Disconnect both battery cables from the battery.

⚠ CAUTION

Ensure that boat is out of the water or seacock is closed and bilge pump is operating before beginning procedure. Excess water in bilge can damage engine or cause boat to sink.

2. Close the seacock, if equipped. If boat is not equipped with a seacock, remove and plug the seawater inlet hose.
3. Drain the seawater system. Refer to SECTION 1B.
4. Disconnect the seawater hoses from the fuel cooler.





a - Rear fuel cooler hose
b - Front fuel cooler hose

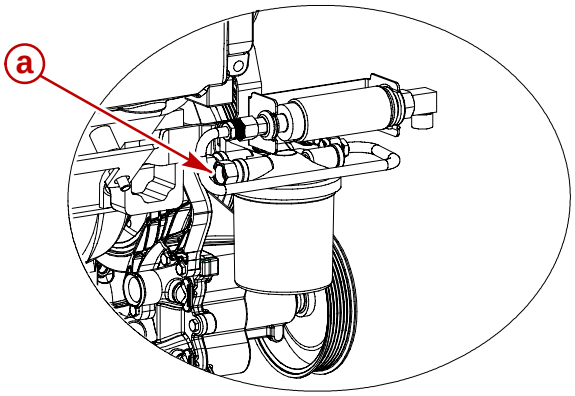
IMPORTANT: Plug open ends of fuel line connections to prevent fuel leaks and entry of water or contaminates into lines while working.

5. Close fuel shut off valve, if equipped, and remove the fuel tank inlet line from the water separating fuel filter or boost pump. If boat is not equipped with a fuel tank shut off valve, remove the fuel tank inlet line at the water separating fuel filter or boost pump and plug the line.
6. Activate the Schrader valve to relieve fuel pressure.

⚠ WARNING

Avoid Fire or Explosion: The fuel injection system is pressurized during operation. Use care when removing the water separating fuel filter. Fuel could spray on the hot engine causing fire or explosion. Allow the engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it, to help avoid fuel spraying on the engine.

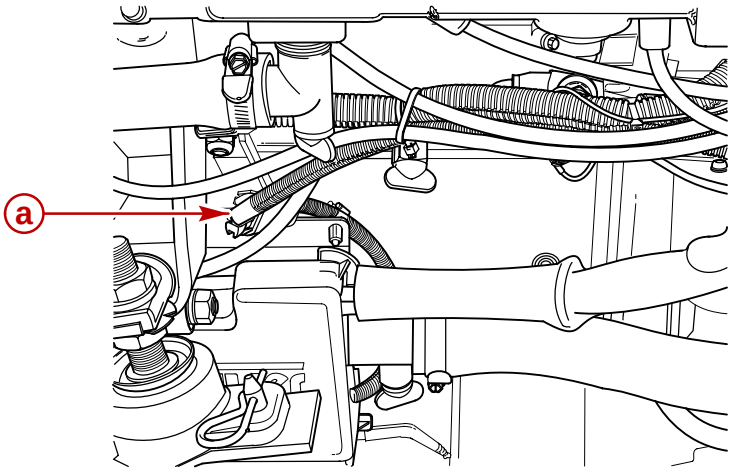
7. Disconnect fuel lines from water separating fuel filter adapter.



79126

a - Filter adapter

8. Disconnect the fuel line from the rail.
9. Disconnect the boost pump and fuel pump electrical connectors.

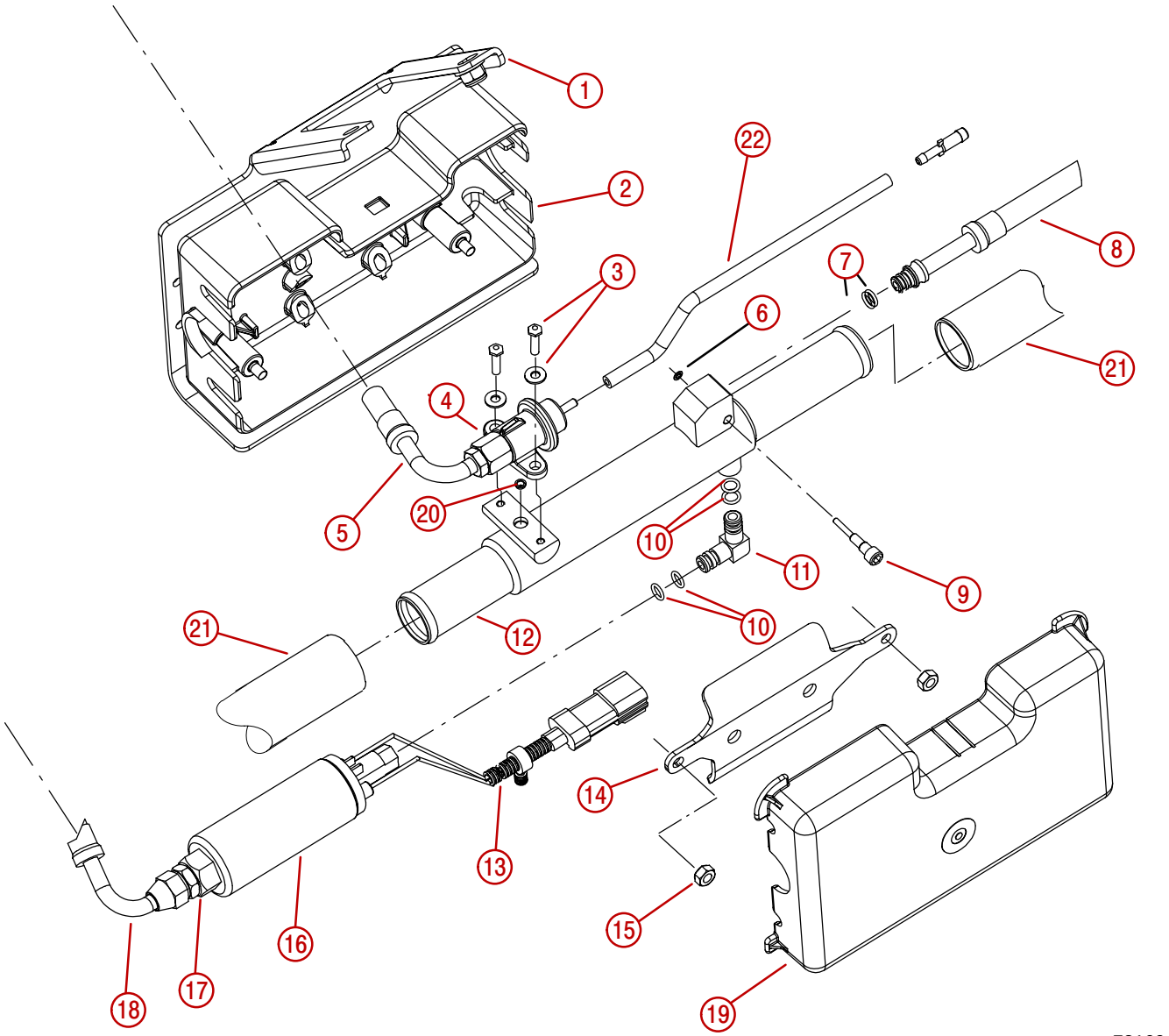


79167

a - Fuel pump electrical connector

10. Disconnect the vacuum hose between the pressure regulator and the intake manifold.
11. Remove the two fuel cooler bracket nuts from the engine mount bracket studs.
12. Carefully remove the cool fuel system assembly.

Disassembly



1 - Bracket
2 - Cover base
3 - Screw and washer (2)
4 - Fuel pressure regulator
5 - Return fuel line
6 - Retaining ring
7 - O-rings (2)
8 - Fuel line, fuel pump-to-fuel rail
9 - Stepped screw
10 - O-rings (4)
11 - Elbow fitting
12 - Fuel cooler
13 - Fuel pump wiring harness
14 - Retainer bracket
15 - Nut (2)
16 - Electric fuel pump
17 - Inlet fitting
18 - Fuel line inlet
19 - Cover
20 - Filter
21 - Seawater hoses (hose clamps not shown)
22 - Vacuum hose

NOTE: *Retain all fasteners and hardware unless instructed otherwise.*

1. Remove the cool fuel system cover.
2. Remove the two nuts from the cool fuel retaining bracket studs.
3. Remove the retainer bracket.
4. Unclip the wiring harness from the cover base.
5. Remove the fuel cooler and the electric fuel pump assembly from the cover base.

IMPORTANT: To prevent loss of the stepped screw used to secure the fuel cooler-to-fuel rail fuel line, a retainer ring is provided. Do not remove the retainer ring or stepped screw.

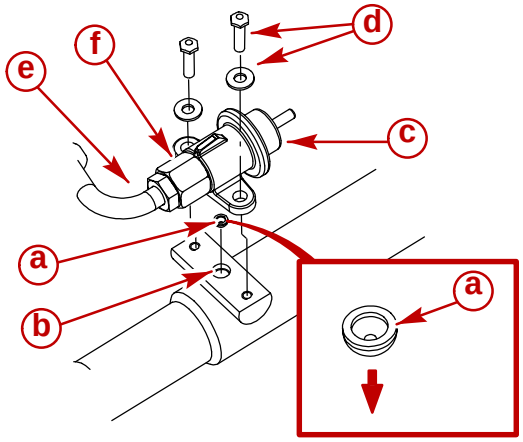
6. Loosen the stepped screw and remove the fuel line.
7. Hold the fuel line and fuel pump or fuel cooler fittings securely and remove the fuel lines.
8. Disconnect the elbow fitting and fuel pump from the fuel cooler assembly by pulling firmly.
9. Remove the elbow fitting from the fuel pump by pulling firmly.
10. Hold the fuel line and regulator fittings securely and remove the fuel line.
11. Remove the fuel line fitting from the fuel pressure regulator.
12. Remove the two screws and washers retaining the fuel pressure regulator to the fuel cooler.
13. Remove the regulator.
14. Remove the conical filter from the fuel cooler.
15. Disconnect the vacuum hose from the regulator by pulling firmly.

Reassembly

1. Install the small filter (conical side DOWN) in the orifice of the new fuel cooler where the fuel pressure regulator mounts.
2. Install the regulator onto the cooler using the two screws with washers. Torque the screws.

Description	Nm	lb-in.	lb-ft
Fuel pressure regulator screws	5.8	53	

3. Install the fitting into the regulator. Tighten securely.
4. Connect the fuel line to the regulator. Tighten securely.

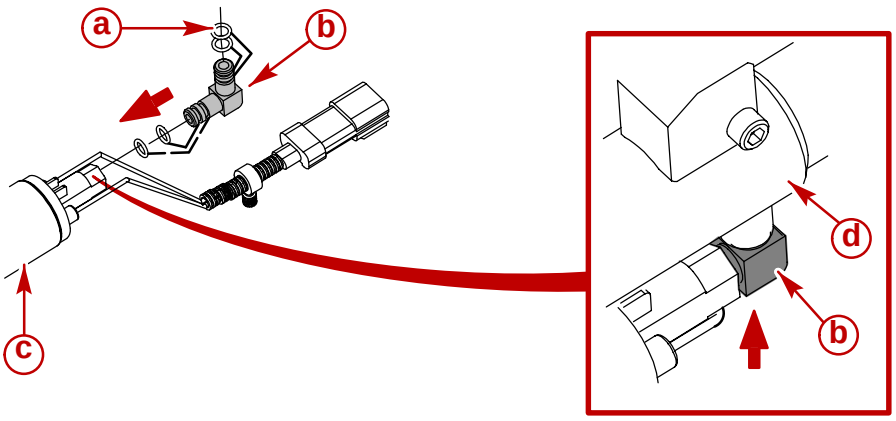


75708

a - Filter
b - Fuel cooler orifice
c - Fuel pressure regulator
d - Screw and washer (2)
e - Fuel line
f - Fitting

5. Install the vacuum hose onto the regulator.
6. Install the 4 O-rings on the fuel pump / cooler elbow fitting.
7. Lubricate O-rings for the elbow fitting with a small amount of liquid dish soap (obtain locally).

8. Install the elbow fitting in the fuel pump.
9. Install the fuel pump with elbow fitting in the cooler assembly.



75708

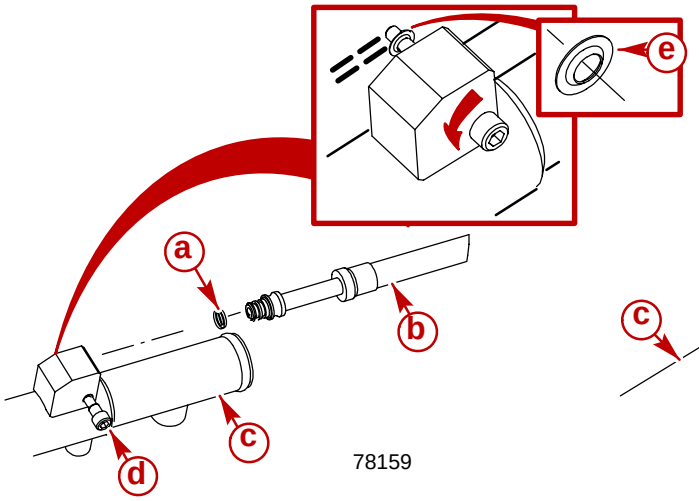
a - O-rings (4)
b - Elbow fitting
c - Fuel pump
d - Fuel cooler

10. Install the fitting into the end of the fuel pump.
11. Install the fuel line for the water separating fuel filter to the fuel pump fitting.
12. Install fuel line seal onto the cooler-to-fuel rail fuel line where it attaches to the cooler.
13. Completely loosen, but do NOT remove, the stepped screw that retains the fuel line.
14. Lubricate the fuel line seal with a small amount of liquid dish soap (obtain locally).

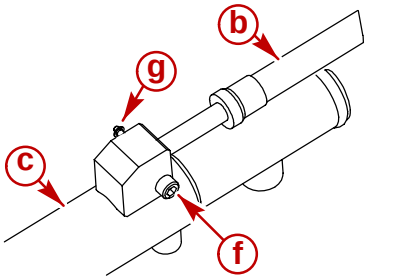
15. Insert the fuel line into the cooler orifice. Torque the stepped screw.

Description	Nm	lb-in.	lb-ft
Stepped screw	9	81	

IMPORTANT: To prevent loss of the stepped screw used to secure the cooler-to-fuel rail fuel line, a retainer ring is provided. Do not remove the retainer ring or stepped screw.



78159

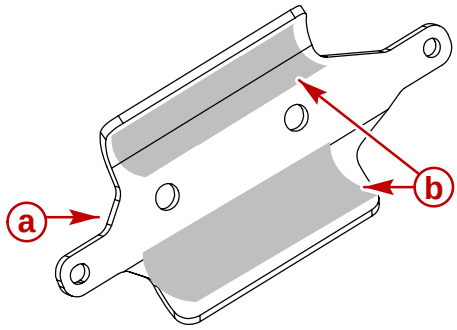


75708

a - Fuel line seal
b - Fuel line, fuel cooler-to-fuel rail
c - Fuel cooler
d - Stepped screw - loosened to accept fuel line
e - Retainer ring
f - Stepped screw - torqued
g - Retainer ring

16. Position the completed fuel cooler assembly in the cover base.

17. Apply a thin, even coating of grease on all of the retainer bracket inside surfaces where it contacts the cooler and the fuel pump when installed.



a - Retainer bracket
b - Thermal grease

Description	Where Used	Part Number
Dielectric Grease	Cool fuel retainer bracket	92-823506-1

18. Install the retainer bracket over the cooler and fuel pump. Apply sealant to the threads of the mounting studs.

Description	Nm	lb-in.	lb-ft
Retainer bracket nuts	5.6	50	

Description	Where Used	Part Number
Loctite 242	Fuel Cooler Mounting Studs	92-809821

Installation

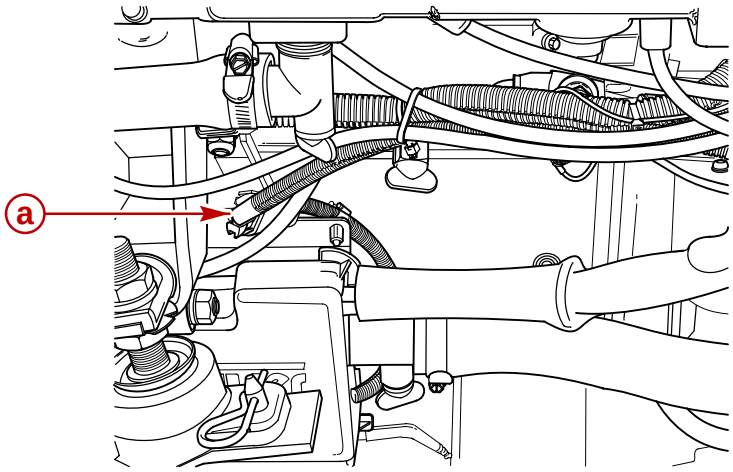
1. Place the cool fuel assembly on the engine mount studs. Install the two nuts.

Description	Nm	lb-in.	lb-ft
Engine mount studs nuts	41		30

2. Connect the fuel lines to the fuel filter adapter and tighten securely.

Description	Nm	lb-in.	lb-ft
Fuel lines	24		19

3. Connect fuel line to the fuel rail.
4. Connect vacuum line to intake manifold.
5. Attach engine harness electrical connectors to fuel pump and boost pump harness connectors.



79167

a - Fuel pump electrical connector

6. Clip fuel pump harness to cool fuel base.

⚠ CAUTION

Do NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.

7. Connect seawater hoses to cool fuel system. Tighten hose clamps securely.
8. Unplug and connect seawater inlet hose. Open seacock, if equipped.
9. Unplug and connect fuel tank inlet line. Tighten hose clamp securely. Open fuel shut off valve, if equipped.

⚠ CAUTION

When installing battery, be sure to connect POSITIVE (+) battery cable to POSITIVE (+) battery terminal FIRST, and NEGATIVE (–) battery cable to NEGATIVE (–) battery terminal LAST. If battery cables are reversed, or connection order is reversed, electrical system damage will result.

10. Clean battery cable clamps and terminals and connect battery cables to the battery. Secure each cable clamp when connecting. Coat terminals with a battery terminal anti-corrosion spray to help retard corrosion.

⚠ WARNING

Fuel vapors can be present in the engine compartment. Avoid injury or power package damage caused by fuel vapors or explosion. Always ventilate the engine compartment prior to servicing the power package.

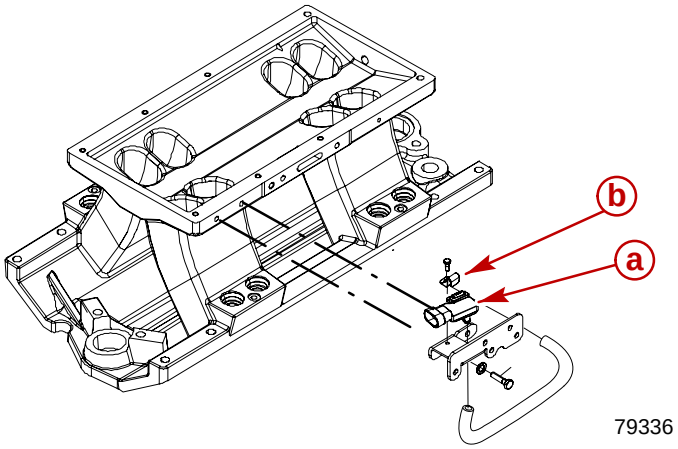
11. Start the engine; check for fuel and water leaks. Stop the engine immediately if any leaks exist. Make necessary corrections.
12. Install cool fuel system cover.

Sensors

Manifold Air Pressure (MAP) Sensor

REMOVAL

1. Disconnect the wiring harness connector from the MAP sensor.
2. Remove the MAP sensor fastener and clip.
3. Remove the MAP sensor from the bracket and ventilation hose.



a - Clip
b - MAP sensor

CLEANING AND INSPECTION

1. Clean the surfaces of the MAP with a dry cloth.
2. Inspect the MAP for signs of wear or damage.

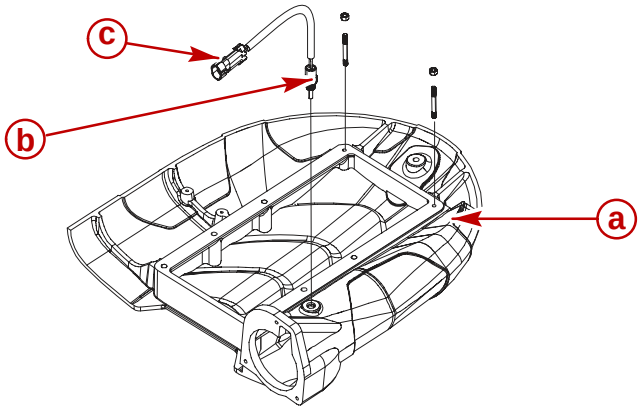
INSTALLATION

1. Install the MAP sensor into the bracket and ventilation hose.
2. Connect electrical connector to the MAP.

Manifold Air Temperature (MAT) Sensor

REMOVAL

1. Disconnect the wiring harness connection from the MAT sensor.
2. Remove the MAT sensor.



79340

a - Underside of plenum
b - Manifold air temperature sensor (MAT)

CLEANING AND INSPECTION

1. Clean the MAT sensor with a dry cloth.
2. Inspect the MAT sensor for signs of wear or damage.

INSTALLATION

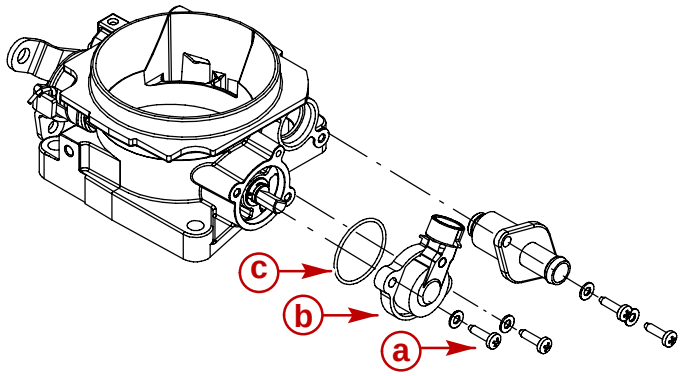
1. Install the MAT sensor into underside of the plenum.

Description	Nm	lb-in.	lb-ft
Manifold air pressure sensor (MAP)	6	53	

2. Connect electrical connector to the MAT.

Throttle Position Sensor (TPS)

1. Remove the flame arrestor.
2. Disconnect the harness connector from the TPS.
3. Remove the screws from the TPS.
4. Remove the TPS from the throttle body.



78124

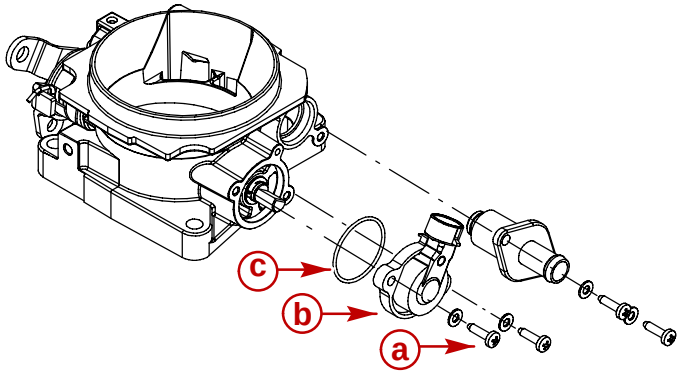
a - Screw (2)
b - Throttle position sensor
c - O-ring

CLEANING AND INSPECTION

1. Clean the surfaces of the TPS with a dry cloth.
2. Inspect the TPS for signs of wear or damage.

INSTALLATION

1. Apply adhesive to screw threads. Install the TPS on the intake manifold. Torque screws.



78124

a - Screw (2)
b - Throttle position sensor
c - O-ring

Description	Where Used	Part Number
Loctite 242	TPS screws	92-809821

Description	Nm	lb-in.	lb-ft
Throttle position sensor (TPS)	2	20	

2. Install throttle body on the intake manifold. Torque nuts.

Description	Nm	lb-in.	lb-ft
Throttle body nuts	10	88	

3. Connect electrical connector to the TPS.
4. Install the flame arrestor.

Description	Nm	lb-in.	lb-ft
Flame arrestor retainer bracket nut	12	108	

5. Install the engine cover.
6. When negative (–) battery cable has been reconnected, start engine and check for TPS output voltage. It should be approximately 0.7 volts at idle and 4.5 volts at wide open throttle.

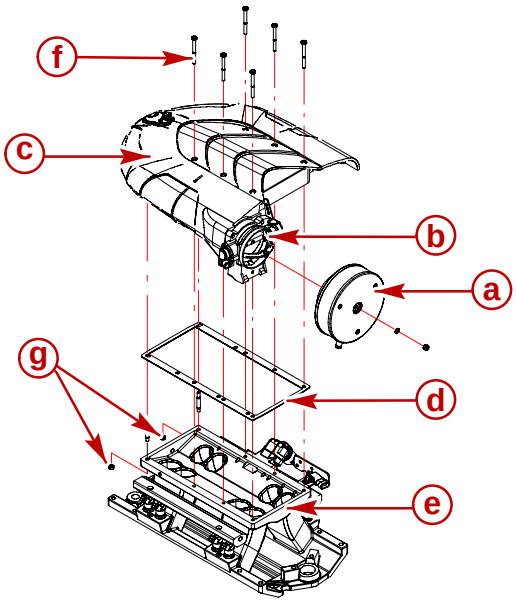
Idle Air Control (IAC) Valve

REMOVAL

⚠ WARNING

Avoid personal injury or death and power package damage The IAC gasket must be replaced anytime the IAC is removed

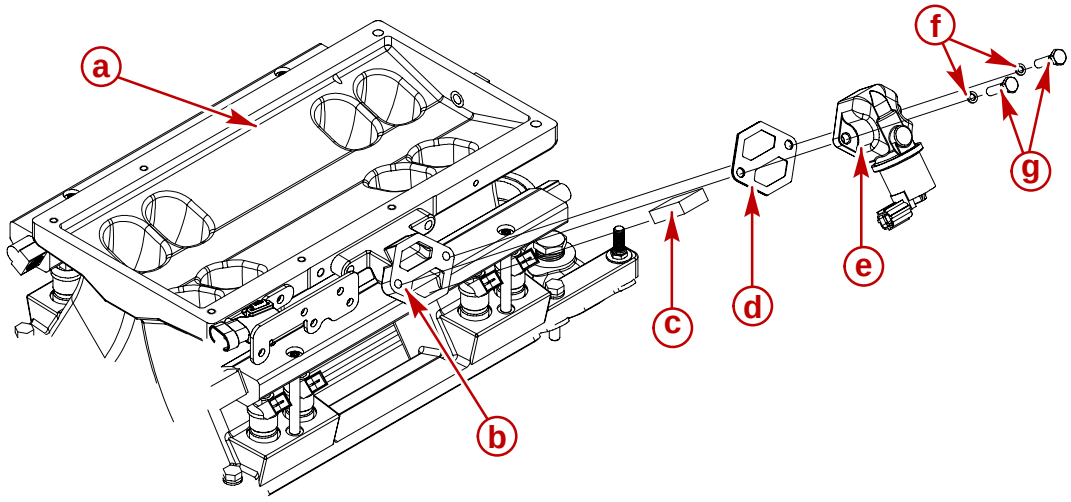
1. Remove the PVC hose from flame arrestor.
2. Remove the flame arrestor from the throttle body.
3. Disconnect the throttle cable at the throttle body.
4. Disconnect the electrical connector to the MAP sensor under the plenum.
5. Disconnect the electrical connector to the TPS at the throttle body.
6. Remove the plenum and the intake to plenum gasket.



79125

a - Flame arrestor
b - Throttle body
c - Plenum
d - Intake to plenum gasket
e - Intake manifold
f - Plenum screw
g - Plenum nut

7. Cover the intake manifold to prevent debris or contaminants from falling into the intake ports.
8. Remove the IAC from the IAC adaptor.
9. Remove and discard the IAC gasket.
10. Remove and discard the IAC filter from the IAC adaptor.



79302

a - Intake manifold
b - IAC adaptor
c - IAC filter
d - IAC gasket
e - IAC
f - IAC washer
g - IAC screw

INSTALLATION

1. Ensure that the mating surface of the IAC adaptor and the IAC are clean and free of debris.
2. Install IAC filter into the IAC adaptor.
3. install the IAC gasket and the IAC onto the IAC adaptor using the IAC screws and washers. Torque the screws.

Description	Nm	lb-in.	lb-ft
IAC screw 1/4-20 x 25 mm (1 in.) long	11		8

4. Connect the electrical connector to IAC.
5. Install the intake gasket and the plenum. Torque the plenum screws and nuts.

Description	Nm	lb-in.	lb-ft
Plenum screw	11		8
Plenum nut	11		8

6. Connect electrical connectors to the MAP sensor and the TPS.
7. Connect the throttle cable at the throttle body.
8. Install the flame arrestor.

Knock Sensor

REMOVAL

1. Disconnect electrical connector at knock sensor located below the port valve cover on the rear of the engine.
2. Remove knock sensors from engine block.

CLEANING AND INSPECTION

1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

INSTALLATION

IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. Do NOT use sealer on threads.

1. Install knock sensor in engine block. Torque nut.

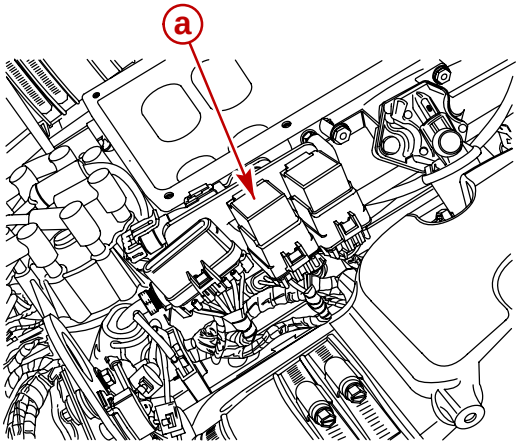
Description	Nm	lb-in.	lb-ft
Knock sensor nut	20		15

2. Connect electrical connector to knock sensor.

Fuel Pump Relay

REMOVAL

1. Remove fuel pump relay from electrical bracket.



79162

a - Fuel pump relay

2. Disconnect electrical connector and remove fuel pump relay.

CLEANING AND INSPECTION

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for signs of wear or physical damage.

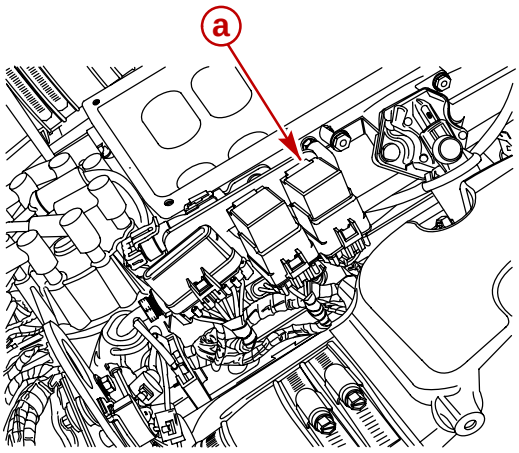
INSTALLATION

1. Connect the electrical connector to the relay.
2. Attach fuel pump relay to bracket.

Main Power Relay

REMOVAL

1. Disconnect the electrical connector and remove the relay.



79162

a - Main power relay

CLEANING AND INSPECTION

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for evidence of damage.

INSTALLATION

1. Attach the electrical connector to the relay.
2. Attach the main power relay to the electrical bracket.

COOLING SYSTEM

Section 6A - All Models

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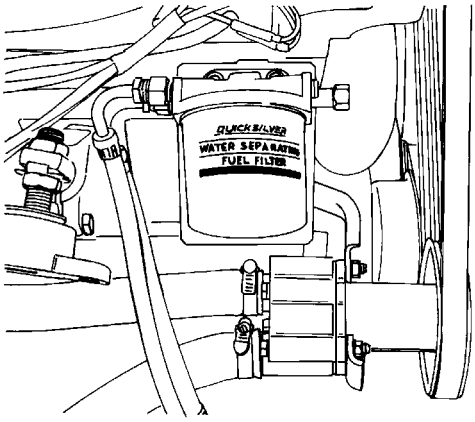
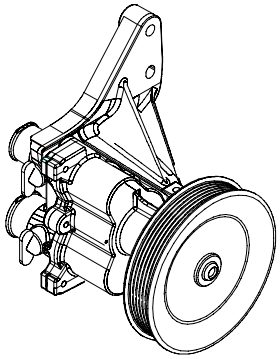
6 A

Identification



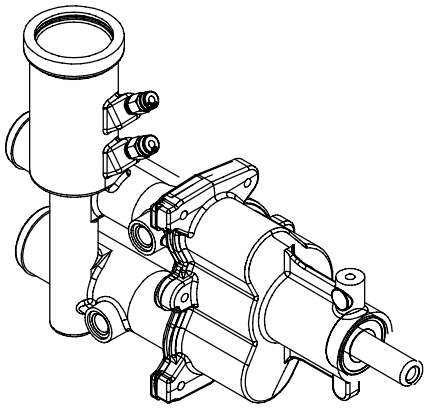
75533

Composite seawater pump



78136

Brass seawater pump without air actuator



78141

Brass seawater pump with air actuator

Specifications

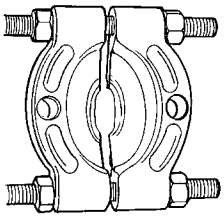
Description	Specification
Water pickup hose	32 mm (1-1/4 in.) ID wire reinforced
Water inlet hose	32 mm (1-1/4 in.) connections
Seacock	
Seawater strainer	

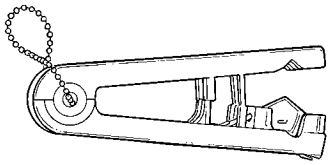
Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Loctite 271 Threadlocker	Seawater pickup fasteners	92-809819
	Bearing housing rear seals	
	Bearing housing front oil seal	
Marine Caulking	Boat hull and seawater pickup joints	Obtain locally
Loctite 567 PST Pipe Sealant	Transom mounted seawater pickup fitting and plastic plug	92-809822
Silicone Sealant	Transom mounted seawater pickup screws	Obtain locally
Engine Oil	Seawater pump bearing shaft	Obtain locally
Loctite 609	Seawater pump retainer/seal	Obtain locally
Perfect Seal	Water circulating pump gaskets and fasteners	92-34227-1
Loctite 242 Threadlocker	Seawater pump cover to housing bolt	92-809821
Loctite 565 PST	Hose fitting threads	Obtain locally
	Plastic plug threads	
Special Lubricant 101	Pump shaft	92-802865A1
2-4-C with Teflon	Quad ring seal	92-802859A1

Equivalent products may be used.

Special Tools

Universal Puller Plate		
 73652	Removes the gears and bearings.	91-37241

Air Line Cutter		
 79013	Prevents collapsing when cutting the air lines for the water drain system on Mercury MerCruiser models equipped with the air actuated water drain system.	91-883502

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

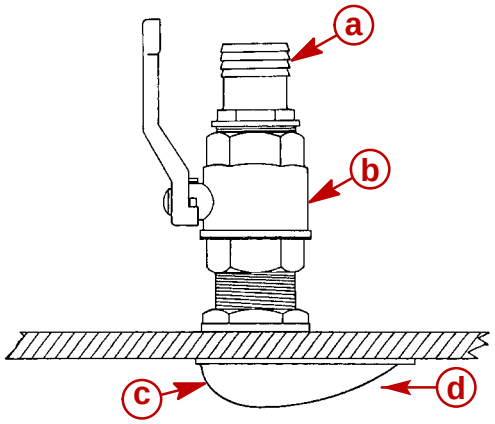
Description	Nm	lb-in.	lb-ft
Seawater pickup nut	47.4		35
Seawater pump cover to housing bolt	9	88	
Seawater pump bracket to engine bolt	40.6		30
Water circulating pump fastener	47.4		35
Water distribution housing bracket bolt and nut	37.9		28
Water distribution housing to bracket screws	13	120	

Seawater Inlet Recommendations

Seacock (Seawater Inlet Valve)

The seacock used must have an internal cross-sectional area equal to or greater than seawater inlet hose to prevent restricting water flow. Install valve in an area where it will be easily accessible and supported adequately to prevent hose fatigue. A brass ball or gate valve is required. Select a proper seacock based on the following chart:

Description	Specification
Seacock Size (Internal Cross-Sectional Area Equal to or Greater Than Size Shown)	32 mm (1-1/4 in.)



70355

Seacock

- **a** - Hose connector 32 mm (1-1/4 in.) ID to seawater pump inlet
- **b** - Seacock 32 mm (1-1/4 in.) brass ball or gate valve
- **c** - Through the hull seawater pickup
- **d** - Direction of seawater flow

Seawater Strainer

Strainer used must be of sufficient size to ensure that an adequate supply of water will be maintained for cooling the engine. Select a proper seawater strainer based on the following chart:

Description	Specification
Seawater Strainer Minimum Flow Rate	114 liter/min (30 gal/min)

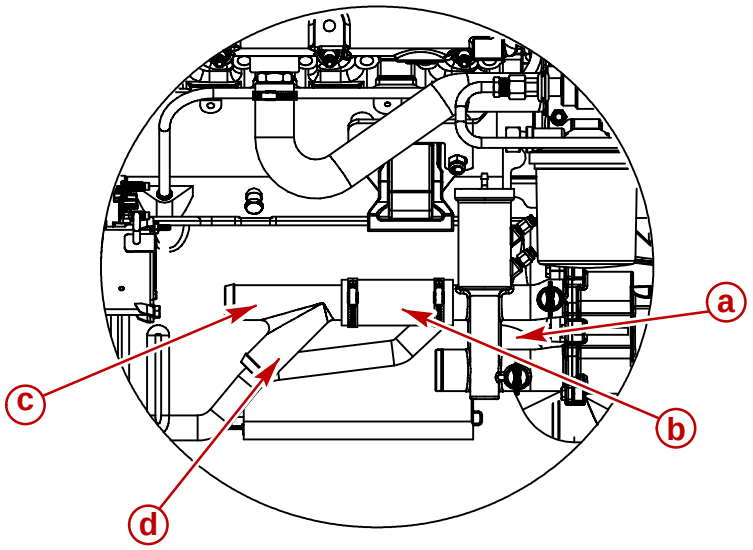
Install seawater strainer in an area where it will be easily accessible for inspection and cleaning. Seawater strainer should be installed in water inlet hose after the seacock (water inlet valve) to allow operator to shut off water when cleaning seawater strainer.

Bravo Closed Cooled Y-Fitting

IMPORTANT: Bravo closed cooled models with warm manifolds require a through the hull or through the transom pickup in addition to the sterndrive water inlets in order to meet the minimum flow specifications.

When additional water inlets are used, a Y-fitting is installed to the engine seawater pump.

1. Install the hose on the engine seawater pump inlet port.
2. Install the Y-fitting on the hose.
3. Secure the hose and the Y-fitting with hose clamps.



78905

a - Engine seawater pump
b - Hose from seawater pump inlet port to Y-fitting
c - Y-fitting port to Bravo drive
d - Y-fitting port to additional water inlet

4. Install the water inlet hoses to the water inlet and the sterndrive.

Seawater Pickup

This section covers through the hull and through the transom water inlets only. For information on sterndrive water inlet connections, refer to the appropriate section after engine installation.

IMPORTANT: Seal the inside edges of any hole made through the hull with a suitable sealant to prevent water absorption and deterioration.

Through the Hull Mounted

NOTE: *Ensure that the hose fitting is 1-1/4 in. diameter.*

IMPORTANT: Seawater pickup must have an integral seacock.

IMPORTANT: Follow seawater pickup manufacturer's installation instructions.

1. Seal inside edges of hole in hull using a suitable sealer.
2. Apply marine caulking (sealer) to mounting surface on seawater pickup where hull contact will occur when installed.

Description	Where Used	Part Number
Marine Caulking	Seawater inlet mounting surfaces	Obtain locally

IMPORTANT: Seawater inlet slots must face forward, parallel with the flow of water.

3. Ensure that the slots in the seawater pickup are facing forward (toward bow of boat) and install seawater pickup through the hull.
4. Apply marine caulking as needed inside boat. Apply sealant to threads of seawater pickup nut and install on pickup on inside of boat.

Description	Where Used	Part Number
Marine Caulking	Seawater inlet mounting surfaces	Obtain locally
Loctite 271 Threadlocker	Seawater inlet nut	92-809819

NOTE: *If seawater pickup being installed does not have mounting screws on underside where mounted to hull, ensure that after seawater pickup nut is torqued slots are still facing forward.*

5. Install a seawater strainer into the water inlet hose.
6. After engine installation, connect the seawater inlet hose from the seawater pickup to the Y-fitting or to the seawater pump inlet fitting, depending upon the model and equipment.

Transom Mounted

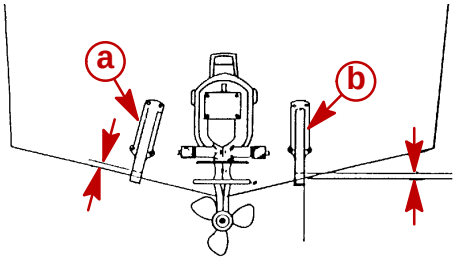
NOTE: *Ensure that the hose fitting is 1-1/4 in. diameter.*

IMPORTANT: Follow seawater pickup manufacturer's installation instructions.

1. Seal the inside edges of the hole using a suitable sealer.

Description	Where Used	Part Number
Loctite 565 PST	Seawater inlet hose fitting threads	Obtain locally
	Seawater inlet plastic plug threads	
Silicone Sealant	Seawater pickup screw shaft	

NOTE: *Some installations may have 5 mm (7/32 in.) holes drilled in transom using four 5/16 in. diameter stainless steel lag bolts in place of round head screws. In any case, flat washers and O-rings are required as outlined.*



72641

Typical water pickup installed on transom

a - Diagonal mount - leading edge of pickup 3 mm (1/8 in.) from boat bottom
b - Vertical mount - corner of leading edge of pickup 3 mm (1/8 in.) from boat bottom

2. Secure water pickup from inside with locknuts and washers (unless using lag bolts).
3. Tighten fasteners securely.
4. After engine installation, connect the seawater inlet hose from the seawater pickup to the Y-fitting or to the seawater pump inlet fitting, depending upon the model and equipment.

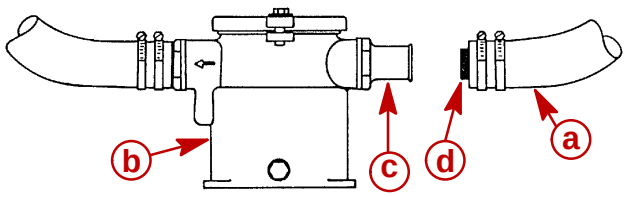
Seawater Strainer

NOTICE
Refer to the manufacturer's instructions for information on other than *Mercury Precision Parts* Seawater Strainer.

Removal

⚠ CAUTION
If the boat is in the water while working on the seawater strainer, close the seacock, if equipped. If the boat is not equipped with a seacock, remove and plug the seawater inlet hose to prevent a siphoning action that may occur, allowing the seawater to flow from the drain holes or removed hoses and enter the boat.

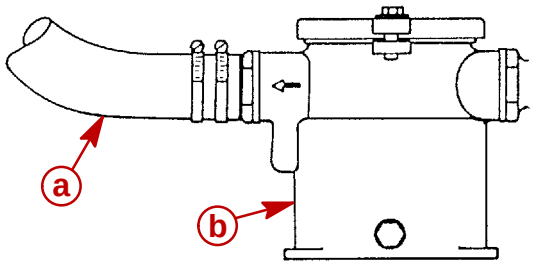
1. **Models equipped with seacock:**
   a. Close the seacock (water inlet valve).
   b. Disconnect the seawater inlet hose from the seawater strainer.
2. **Models without seacock:**
   a. Disconnect the seawater inlet hose from the seawater strainer inlet and plug the seawater inlet hose.



70062

a - Seawater inlet hose
b - Seawater strainer
c - Seawater strainer inlet
d - Plug

3. Remove the outlet hose. Drain into a suitable container.



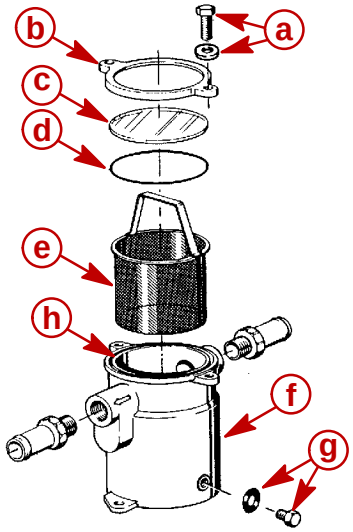
72643

a - Seawater inlet hose
b - Seawater strainer

4. Remove the mounting bolts. Remove the seawater strainer.

Cleaning and Inspection

1. Remove and clean the filter element.
2. Remove the drain plug.



72673

Typical seawater strainer shown

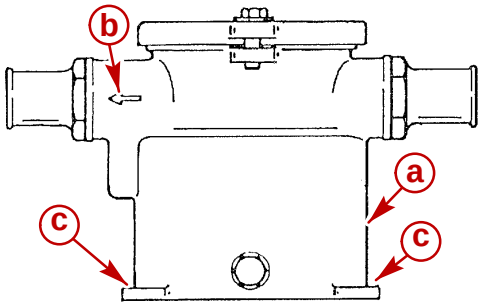
- **a** - Screws and washers
- **b** - Lens cover
- **c** - Glass
- **d** - O-ring
- **e** - Strainer
- **f** - Housing
- **g** - Drain plug and sealing washer
- **h** - Gasket

3. Flush the components with clean water.

Installation

IMPORTANT: Mount the seawater strainer in a vibration-free location. Never mount it on the engine or the transmission. Hoses must not be kinked or allowed to come in contact with hot or moving engine or transmission parts.

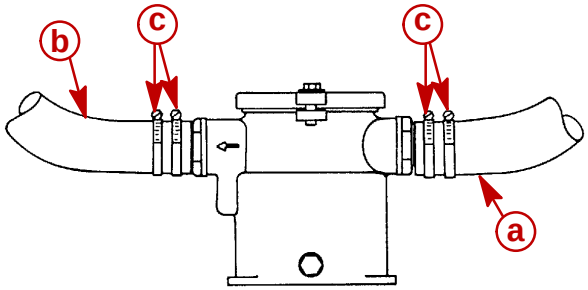
1. Mount the seawater strainer. The arrow indicates the required water flow direction and must point toward the seawater pump. Tighten the mounting bolts securely.



72644

a - Seawater strainer
b - Arrow
c - Mounting bolt hole location (bolts not shown)

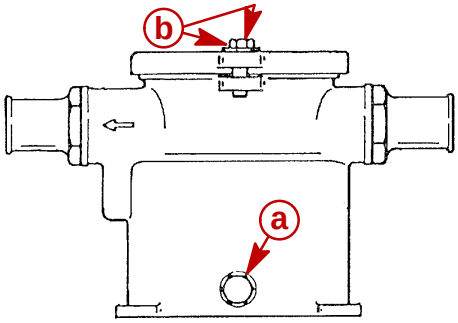
2. Remove the plug from the seawater inlet hose (if installed previously) and install the hose on the strainer. Install the seawater outlet hose. Use 2 hose clamps on each hose connection. Tighten the clamps securely.



72645

a - Seawater inlet hose
b - Seawater outlet hose
c - Double hose clamps

3. Check the drain plug and the lens cover bolts. Tighten securely. Do not overtighten the lens cover bolts or the lens cover may warp and leak water into the boat.



72644

a - Drain plug
b - Lens cover bolts (2, one not shown)

4. Open the seacock, if equipped.

Shaft Log Seal Water Tap Location

The propeller shaft log seal hose should be routed so that a portion of the hose extends above the top of the engine exhaust elbows (to prevent a siphoning action when engine is not operating). Hose must be securely fastened to keep it properly positioned.

⚠ CAUTION

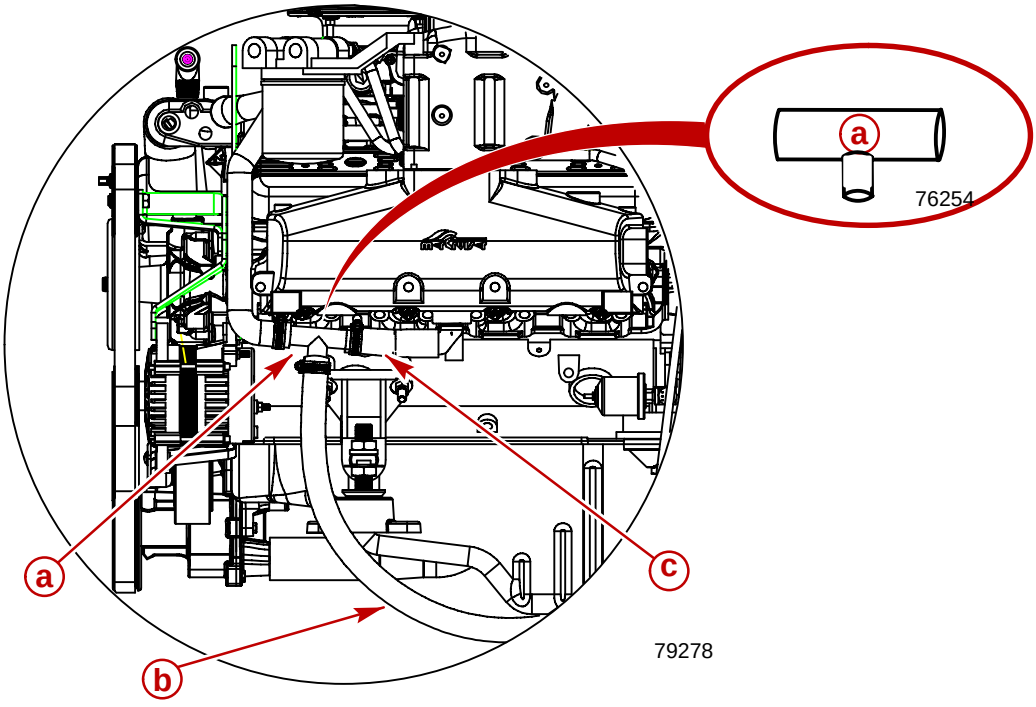
Engine damage may result from failure to route propeller shaft log seal hose properly. This could cause increased exhaust system corrosion, submersion damage, or freeze damage to engine.

IMPORTANT: Tapping into the wrong location can cause the engine to vapor lock or operate too cold.

Early Models

Description	Serial Number
Inboard And Tow Sports (MIE) Models	0M316999 and Below

1. Using a T-fitting, splice into the port exhaust manifold water hose.
2. Install T-fitting.
3. Install shaft log seal hose to T-fitting.
4. Fasten with hose clamps. Tighten securely.



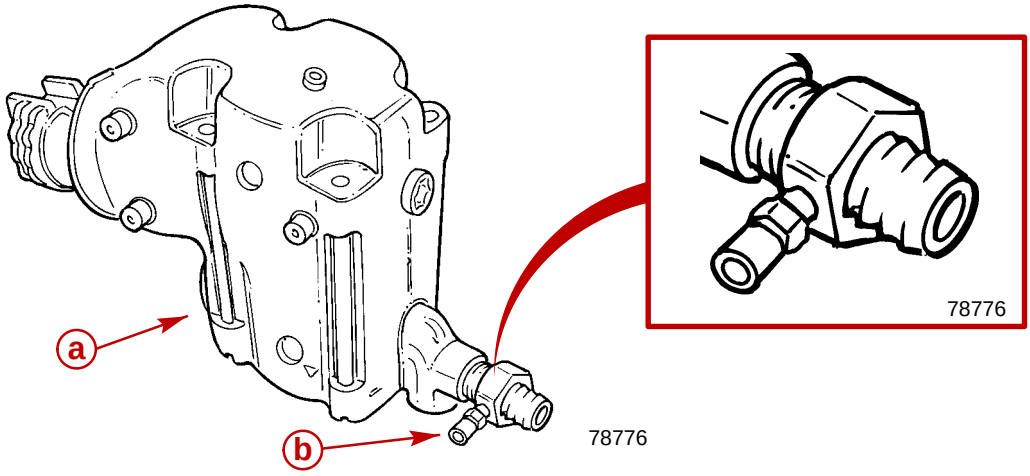
a - T-fitting
b - Hose to shaft log seal
c - Port exhaust manifold water hose

Later Models Except Scorpion Models

Description	Serial Number
Inboard And Tow Sports (MIE) Models	0M317000 and Above

IMPORTANT: If not using a shaft log seal, this fitting must remain plugged.

1. Remove the shaft log seal plug.
   a. Install shaft log seal fitting.
   b. Attach the shaft log seal cooling water hose to the shaft log seal fitting.
   c. Route the propeller shaft log seal hose so that a portion of the hose extends above the top of the engine exhaust elbows.



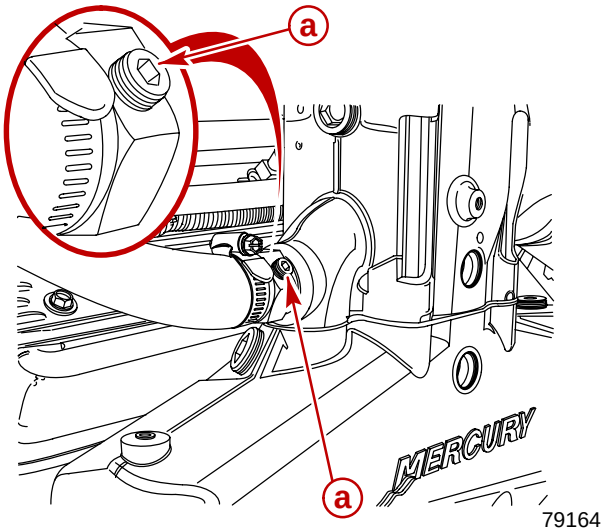
a - Port exhaust elbow
b - Shaft log seal fitting at 8 o'clock position

Scorpion Models

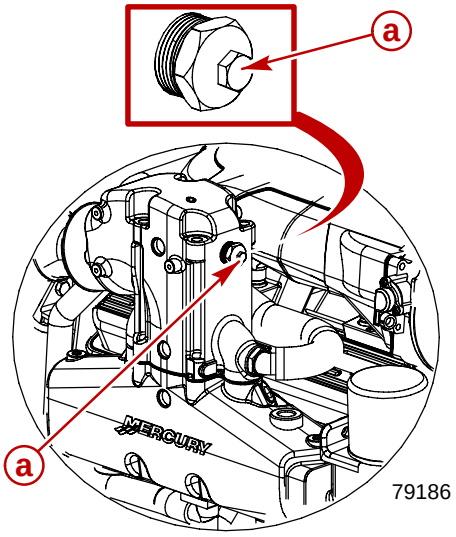
0M391600 AND ABOVE

Description	Serial Number
Black Scorpion	0M391600 and Above
MX 6.2 Black Scorpion	0M391750 and Above

1. Remove the shaft log seal plug from the port exhaust elbow. V-Drive models: ensure that brass reducer fitting remains secure in exhaust elbow casting.
   a. Install shaft log seal fitting.
   b. Attach the shaft log seal cooling water hose to the shaft log seal fitting.
   c. Route the propeller shaft log seal hose so that a portion of the hose extends above the top of the engine exhaust elbows.
   d. Fasten hose and hose connections securely.



In-line models



V-drive models

a - Brass plug

Hot Water Heater Installation

IMPORTANT: When connecting a cabin heater or hot water heater:

- **Supply hose (from engine to heater) and return hose (from heater to engine) MUST NOT EXCEED 16 mm (5/8 in.) ID.**
- **Make heater connections ONLY at locations shown.**
- **Refer to manufacturers' instructions for complete installation information and procedures.**
- **Do not reposition engine temperature switch.**

NOTE: *Some models may be equipped with additional fittings.*

⚠ CAUTION

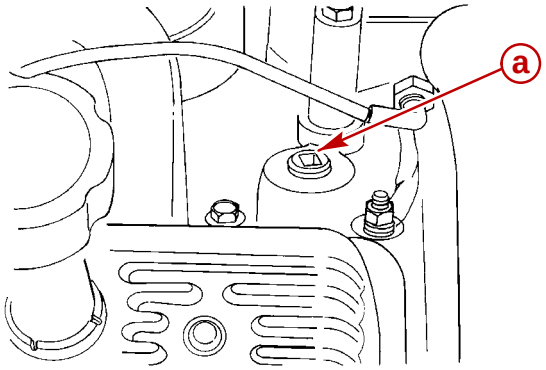
Avoid a performance loss and/or possible engine damage. Engine coolant must flow continuously from the engine intake manifold to the engine water circulating pump. NEVER close off or block the coolant flow to or from a heater.

⚠ CAUTION

Avoid engine overheating which could result in engine damage. On models equipped with Closed Cooling, an air pocket may form in the closed cooling system if some coolant is lost from the system and the cabin heater or hot water heater is mounted higher than the fill cap on the heat exchanger. Heater must be mounted lower than the fill cap of the heat exchanger on models so equipped.

Seawater Cooled Models

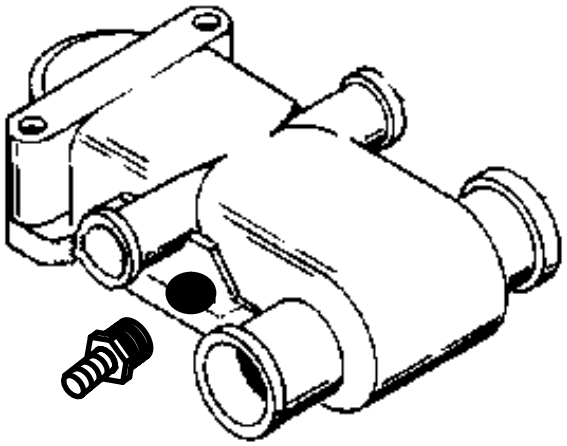
SUPPLY HOSE CONNECTION FOR EARLY MODELS



74973

Carbureted manifold intake shown

a - Intake manifold plug

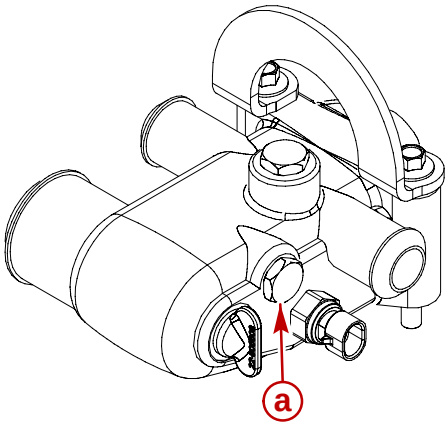


75149

Supply hose alternate location

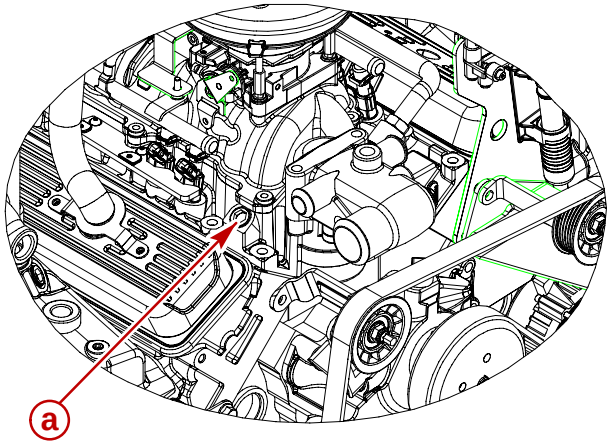
a - Thermostat housing
b - Hose connector

SUPPLY HOSE CONNECTION FOR AIR OR MANUAL DRAIN MODELS



78907

a - Thermostat housing plug

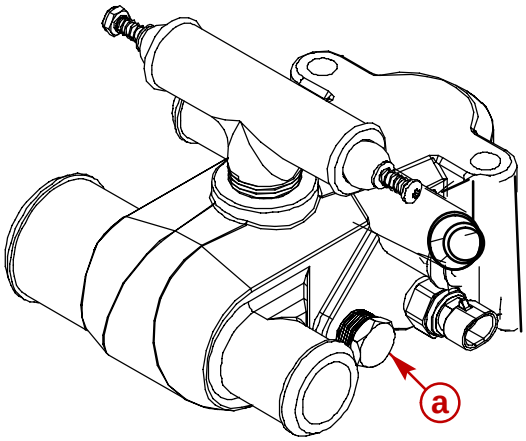


78692

MPI intake manifold shown

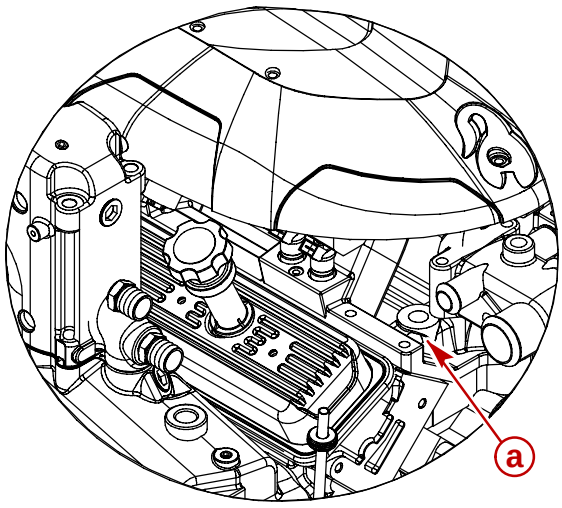
a - Intake manifold plug

SUPPLY HOSE CONNECTION FOR MULTIPLE POINT DRAIN MODELS



78908

a - Thermostat housing plug



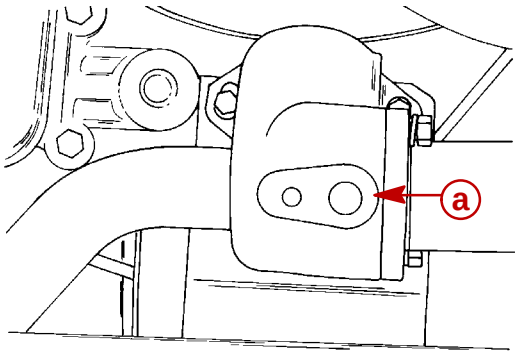
79124

Scorpion intake manifold shown

a - Intake manifold plug

Closed Cooled Models

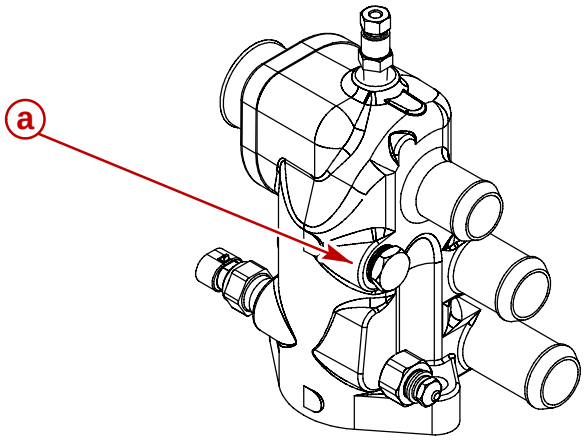
SUPPLY HOSE CONNECTION FOR EARLY MODELS



75503

a - Thermostat housing plug (viewed from above)

SUPPLY HOSE CONNECTION FOR LATER MODELS

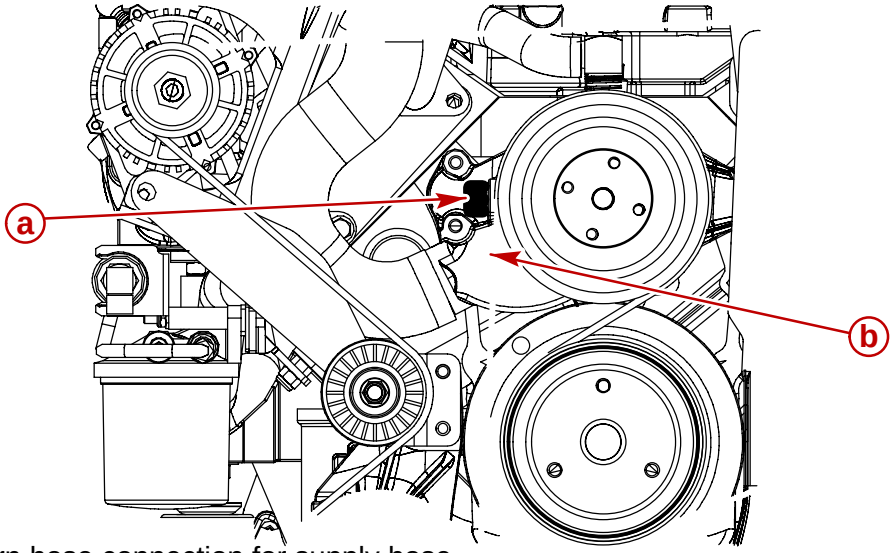


78691

a - Thermostat housing plug

Return Hose Connection For All Models

The return hose is located on the water circulating pump housing of all engine models.



a - Return hose connection for supply hose
b - Water circulating pump housing

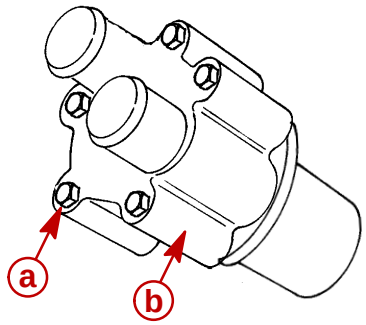
Seawater Pump Removal

1. Drain the seawater section of the cooling system.
2. Close seacock valve, if applicable.
3. Remove both of the hoses from the aft side of the seawater pump.
4. Remove the serpentine belt.
5. Remove the two bolts attaching the seawater pump and bracket to the engine.

Composite Seawater Pump

DISASSEMBLY

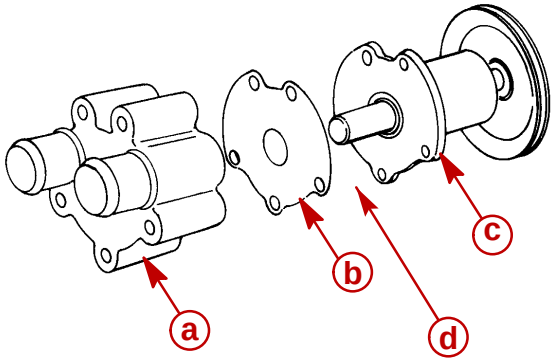
1. Remove the 5 screws from the seawater pump body.



75277

a - Screws (5)
b - Seawater pump body

2. Remove seawater pump body and wear plate from bearing housing.



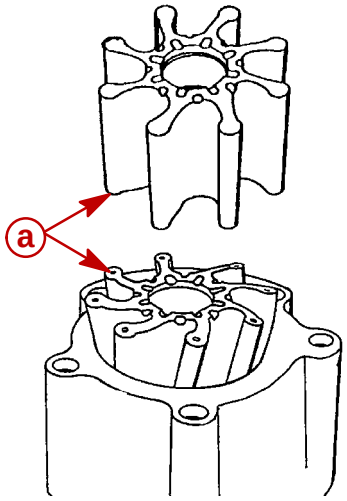
75275

a - Seawater pump body
b - Wear plate
c - Bearing housing

3. Remove the impeller from seawater pump body.

REASSEMBLY

1. Lubricate seawater pump impeller with a water and soap solution. Install impeller into housing by rotating and pushing it into place. Push it down until flush with housing.

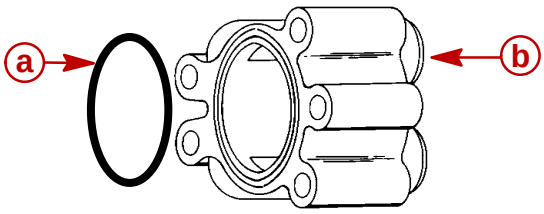


71118

71150

a - Impeller

2. Place wear plate over bearing housing shaft.
3. Place quad ring in groove in seawater pump body.

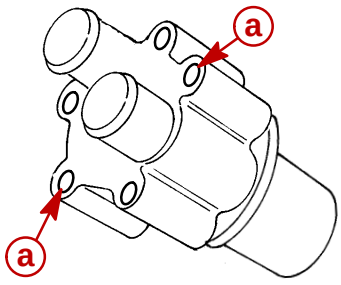


a - Quad ring
b - Seawater pump

4. Align flats on impeller and bearing housing shaft. Slide seawater pump body on shaft.

NOTE: *Reassembly of the pump requires the mounting bracket to be installed while performing the following step.*

5. Install 2 screws in seawater pump body holes as shown. Use these 2 screws to align pump, then install the remaining screws.

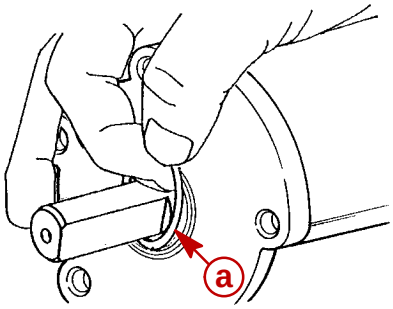


75277

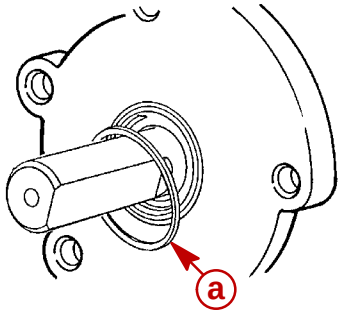
a - Bolt holes for alignment

SEAWATER PUMP BEARING HOUSING DISASSEMBLY

1. Remove gasket, inner wear plate, and quad ring seal. Discard gasket and quad ring seal.



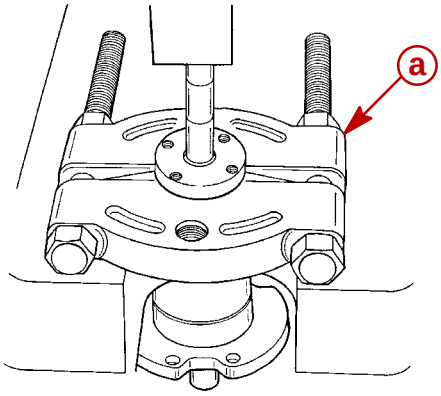
72655



72656

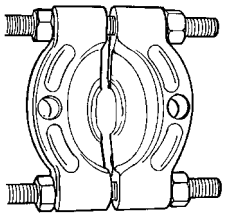
a - Quad ring seal

2. Press hub off shaft with Universal Puller Plate and an arbor press.

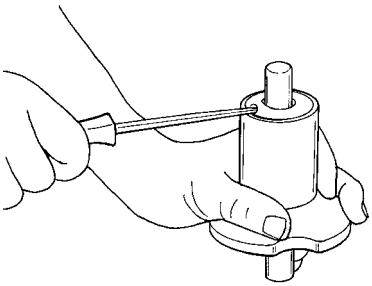


72648

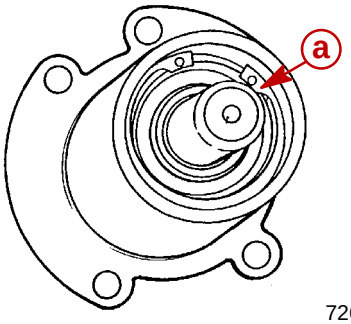
a - Universal Puller Plate

Universal Puller Plate		
 73652	Removes the gears and bearings.	91-37241

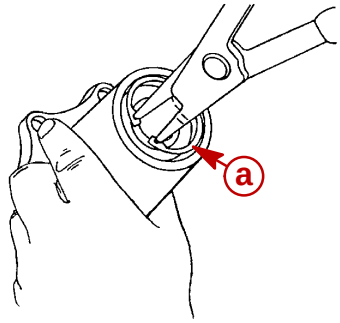
3. Puncture front oil seal with a tool and pry from bearing housing.


72649

4. Remove snap ring from bearing housing bore and press shaft and bearings out pulley end of housing. Bearings have a slip fit in housing; do not use excessive force.



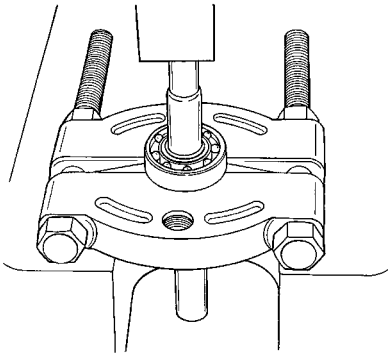
72657

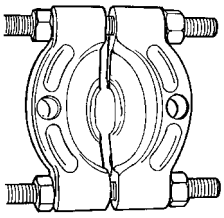


72658

a - Snap ring

5. If bearings require replacement, remove bearings from shaft with Universal Puller Plate and an arbor press. Bearings must be replaced if removed.


72659

Universal Puller Plate		
 73652	Removes the gears and bearings.	91-37241

6. If rear seals require replacement, press seals from bearing housing with an appropriate tool.

CLEANING AND INSPECTION

IMPORTANT: Do not spin bearings at high speed when drying with compressed air, as bearings may be scored.

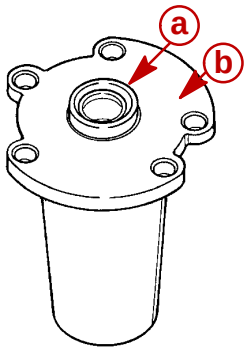
1. Clean metal parts in solvent and dry with compressed air.
2. After cleaning, lightly coat the shaft and the bearings with lubricant to prevent rust.

Description	Where Used	Part Number
Engine oil	Seawater pump bearing shaft	Obtain locally

3. Clean all gasket material and sealer from sealing surfaces.
4. Inspect bearing housing. Examine surfaces (where bearings contact housing) for evidence of bearing outer races turning in housing.
5. Inspect seals in bearing housing.
6. Inspect pump shaft bearings.
7. Inspect pump shaft for grooves in surface where seals contact shaft. Also inspect surface where bearings contact shaft for evidence of inner races turning on shaft.
8. Inspect pump body.
9. Inspect inner and outer wear plate.
10. Inspect pump impeller for wear on sides and tips of blades. Also inspect blades for cracks in area where blades flex. Replace impeller if blades have taken a set (remain in curved position).
11. Inspect pump pulley.
12. Inspect drive belt for excessive wear.

REASSEMBLY

1. Apply a thin coat of sealant to outside diameter of 2 new rear seals; then install rear seals in bearing housing with seal edges facing impeller end. Press first seal in until it seats and second seal (water seal) in until flush with bearing housing.



72660

a - Outer water seal
b - Face of housing

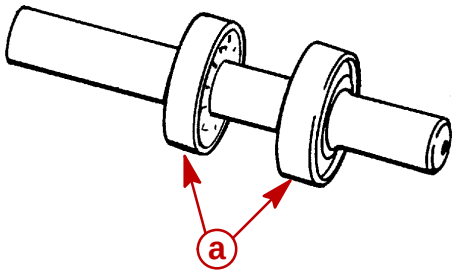
Description	Where Used	Part Number
Loctite 271 Threadlocker	Bearing housing rear seals	92-809819

IMPORTANT: It is recommended that Shell Alvania RL2 Grease be used when packing seal and bearings in the following steps. If Shell Alvania RL2 Grease is not available, it is permissible to use 2-4-C with Teflon. However, 2-4-C with Teflon is not recommended for applications where continuous high speed heavy-duty operation will be encountered.

2. Pack cavity between seals with lubricant.

Description	Where Used	Part Number
Shell Alvania RL2 Grease	Cavity between seals	Obtain locally

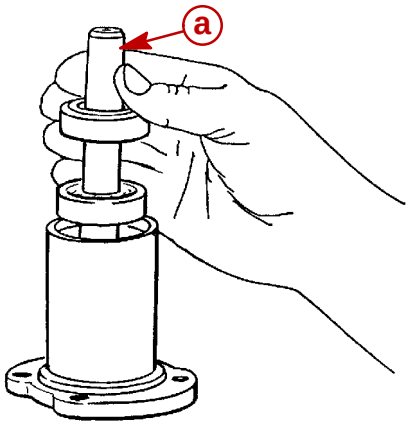
3. Using an arbor press and suitable tool, press ball bearings onto shaft until they seat. Press on inner race of bearing only.



72663

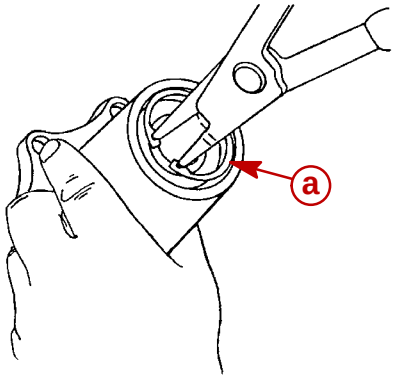
a - Bearings

4. Pack bearings and cavity between bearings with lubricant. Slide bearings and shaft into bearing housing bore and install snap ring.



72661

a - Shaft with bearings

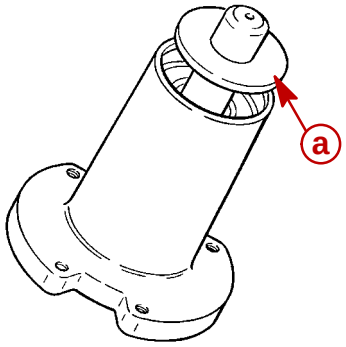


72658

a - Snap ring

Description	Where Used	Part Number
Shell Alvania RL2 Grease	Cavity between bearings	Obtain locally

5. Apply a thin coat of sealant to outside diameter of new bearing housing front oil seal and press seal into housing (with seal edge facing inward) until it seats.



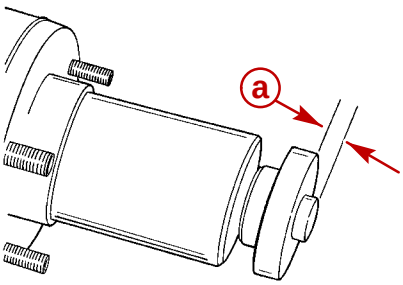
72662

a - Front oil seal

Description	Where Used	Part Number
Loctite 271 Threadlocker	Bearing housing front oil seal	92-809819

IMPORTANT: Support impeller end of pump shaft when installing pulley hub to prevent placing a load on bearings.

6. Apply lubricant to pump shaft. Using an arbor press and appropriate tool, press pulley hub onto pump shaft to dimension specified.



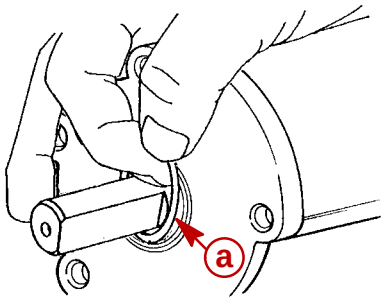
72664

a - 7 mm (.260 in.)

Description	Where Used	Part Number
Special Lubricant 101	Pump shaft	92-802865A1

IMPORTANT: Pulley hub must be pressed onto pump shaft to exact dimension on pumps with stamped steel mounting bracket as this establishes proper drive belt alignment.

7. Clamp bearing housing in a soft-jawed vise with flange end up.
8. Coat quad ring seal with lubricant and install into groove in housing.

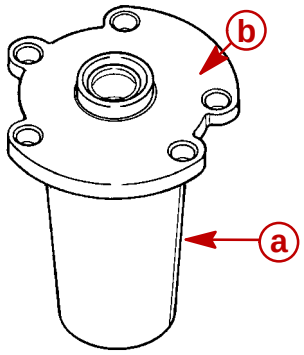


72655

a - Quad ring seal

Description	Where Used	Part Number
2-4-C with Teflon	Quad ring seal	92-802859A1

9. Place the wear plate over the bearing housing.



72660

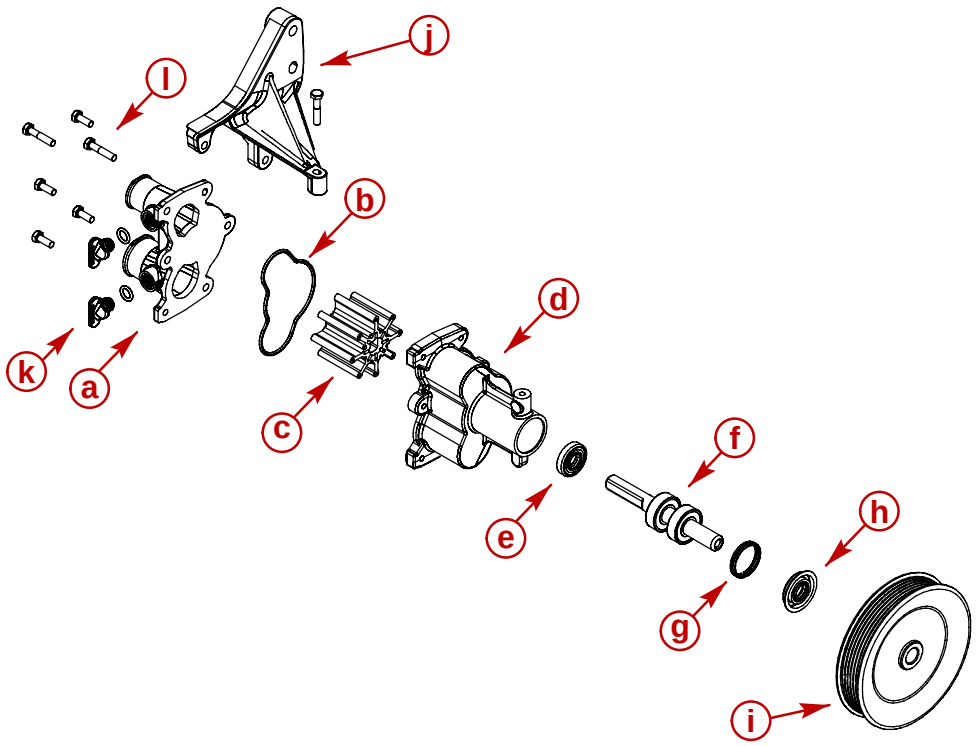
a - Bearing housing
b - Wear plate

Brass Seawater Pump

DISASSEMBLY

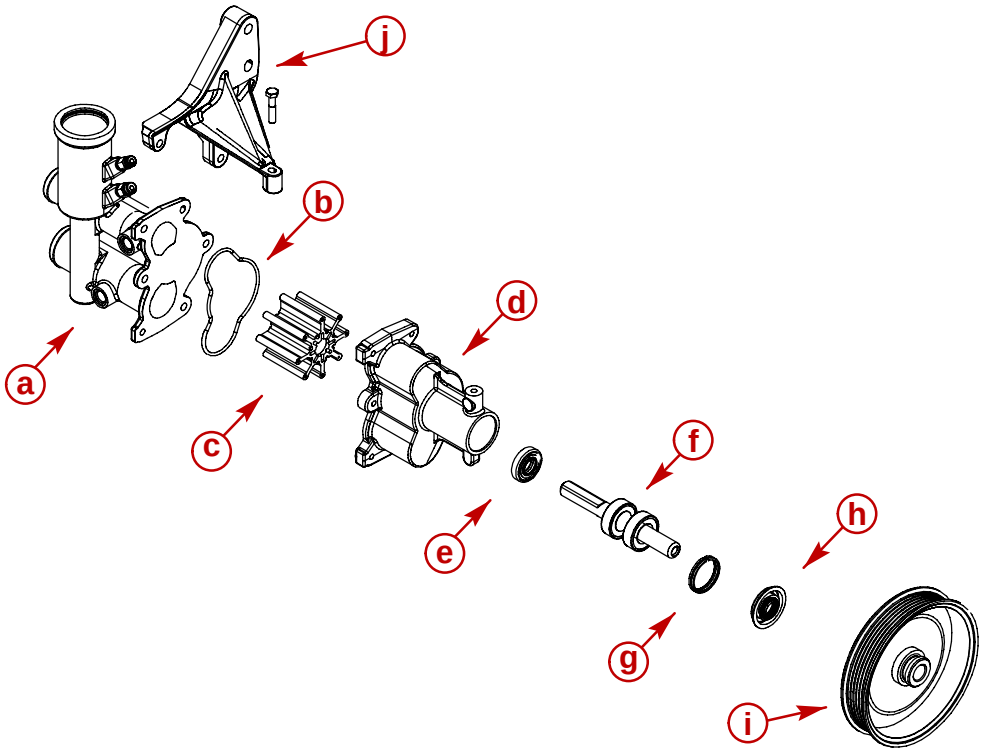
1. Press off the pulley.
2. Remove the 6 bolts from the rear of the seawater pump.
3. Remove and discard the O-ring.
4. Remove the impeller.
5. Remove the retainer/seal from the front of the seawater pump.
6. Remove the tolerance ring.
7. From the impeller side, press the bearing shaft out of the housing.
8. Remove the rear oil seal from the housing.

79356



Multiple point drain system

- **a** - Seawater pump back plate
- **b** - O-ring
- **c** - Impeller
- **d** - Seawater pump bearing housing
- **e** - Rear oil seal
- **f** - Bearing shaft assembly
- **g** - Tolerance ring
- **h** - Retainer/Seal
- **i** - Pulley
- **j** - Seawater pump bracket
- **k** - Blue drain plug and O-ring (2 each)
- **l** - Bolt (6)



78136

Air actuated drain system

a - Seawater pump back plate (single point drain system)
b - O-ring
c - Impeller
d - Seawater pump bearing housing
e - Rear oil seal
f - Bearing shaft assembly
g - Tolerance ring
h - Retainer/Seal
i - Pulley
j - Seawater pump bracket

CLEANING AND INSPECTION

1. Clean the metal parts in solvent and dry with compressed air.

IMPORTANT: Do not spin the bearings at high speed when drying with compressed air, as the bearings may be scored.

2. After cleaning, lightly coat the shaft and the bearings with lubricant to prevent rust.

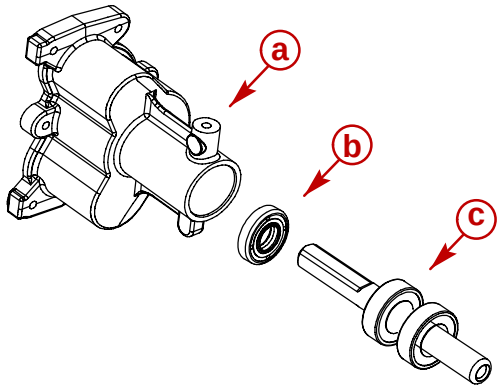
Description	Where Used	Part Number
Engine oil	Seawater pump bearing shaft	Obtain locally

3. Clean all gasket material and sealant from the sealing surfaces.
4. Inspect the bearing housing. Examine the surfaces (where the bearings contact the housing) for evidence of the bearing outer races turning in the housing.
5. Inspect the seals in the bearing housing.
6. Inspect the pump body.
7. Inspect the pump impeller for wear on the sides and the tips of the blades. Also inspect the blades for cracks in the area where the blades flex. Replace the impeller if the blades have taken a set (remain in curved position).
8. Inspect the pump pulley.
9. Inspect the serpentine drive belt for excessive wear.

REASSEMBLY

1. Place the rear oil seal into the bearing shaft housing with the side with the spring towards the impeller cavity.
2. Lubricate the bearing shaft assembly.

Description	Where Used	Part Number
Engine oil	Seawater pump bearing shaft	Obtain locally



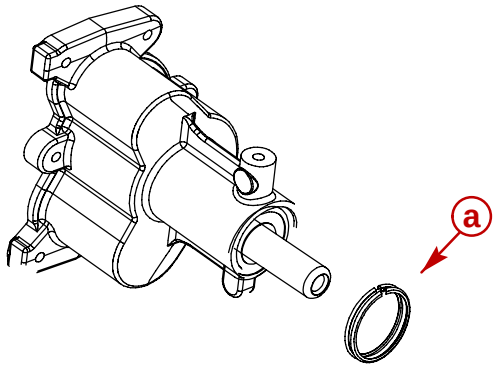
78137

a - Seawater pump bearing housing
b - Rear oil seal
c - Bearing shaft assembly

NOTE: *The bearing shaft assembly into the seawater pump bearing housing is a slip fit and only requires light force to install.*

3. Install the bearing shaft assembly into the housing.

4. Install the tolerance ring.



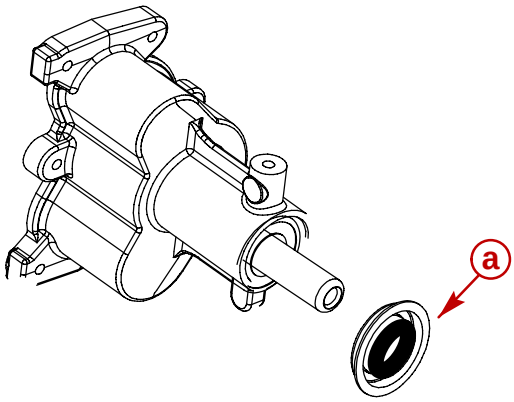
78138

a - Tolerance ring

5. Apply adhesive to the retainer/seal outer edges. Do not apply adhesive to the seal portion of the retainer.

Description	Where Used	Part Number
Loctite 609	Seawater pump retainer/seal	Obtain locally

6. Place retainer/seal on the shaft and press it into place.

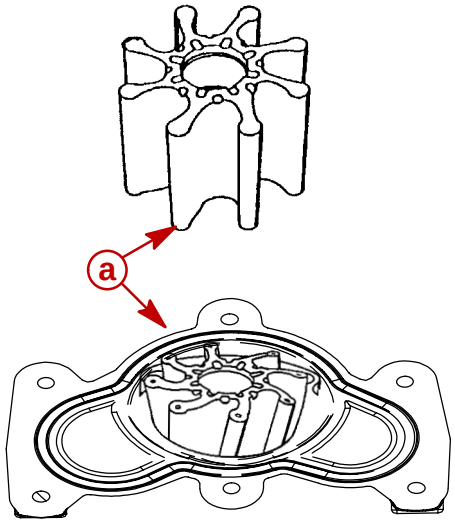


78139

a - Retainer/Seal

7. Wipe away excess adhesive.
8. Lubricate the impeller with soapy water.

9. Install the impeller into the pump body.

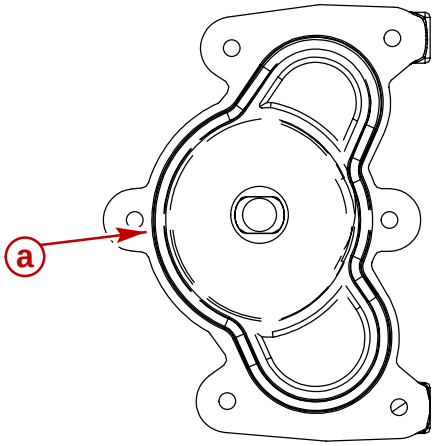


71118

71150

a - Impeller

10. Install the O-ring into the groove on the pump body.



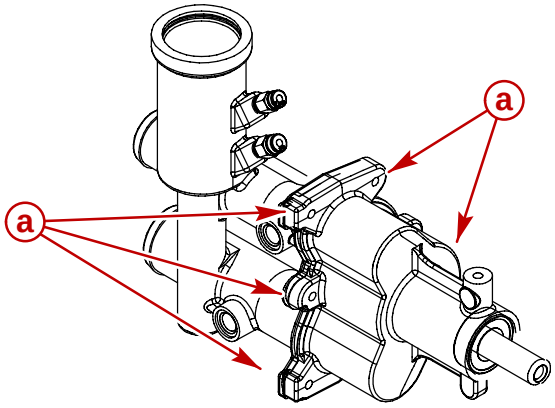
78140

a - O-ring groove

11. Align pump body with the back plate.
12. Apply sealant to seawater pump bolt threads.

Description	Where Used	Part Number
Loctite 242 Threadlocker	Seawater pump cover to housing bolt	92-809821

13. Install bolts and torque.



78141

a - Seawater pump bolts

Description	Nm	lb-in.	lb-ft
Seawater pump bolt	9	88	

Seawater Pump Installation

1. Fasten the seawater pump and bracket to the engine. Torque the bolts.

Description	Nm	lb-in.	lb-ft
Seawater pump bracket to engine bolt	40.6		30

2. Attach the hoses to the aft side of the seawater pump. Tighten the hose clamps securely.

NOTE: *Do not use a press to install the seawater pump pulley because it will damage the bearings.*

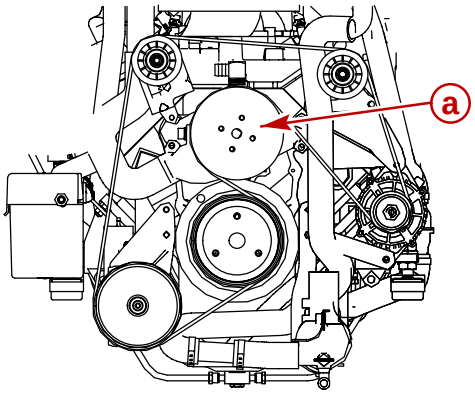
3. Press the pulley onto the seawater pump shaft using a screw with a flat washer as a pressing tool assembly. The washer should be larger than the pulley's ID.
   a. Align seawater pump pulley to the seawater pump shaft.
   b. Engage the screw assembly into the threaded ID of pump shaft.
   c. Further engage the screw to force pulley onto the pump shaft.
4. Install the serpentine belt.

Water Circulating Pump

Removal

NOTE: *The water circulating pump pulley on the warm manifold closed cooled models is a new design and cannot be replaced with previous Mercury MerCruiser water circulating pump pulley.*

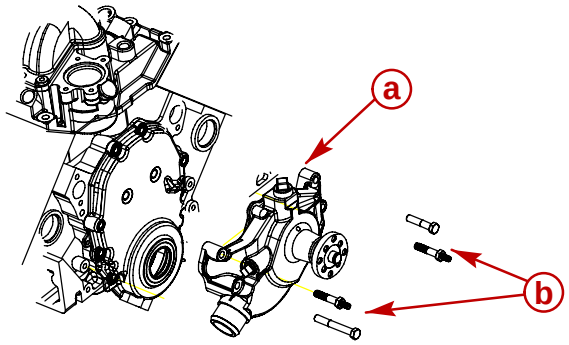
1. Allow engine to cool.
2. Drain the seawater or closed cooling section of the engine.
3. Remove the hoses attached to the water circulating pump.
4. While holding the water circulating pump pulley in place, loosen the pulley bolts.
5. Remove serpentine belt.
6. Remove water circulating pump bolts and pulley.



77954

a - Water circulating pump pulley

7. Remove the fasteners and the water circulating pump.



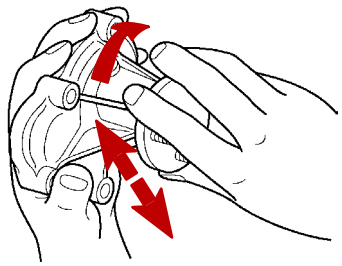
77954

a - Water circulating pump
b - Fasteners

8. Remove and discard the old gaskets.

Cleaning and Inspection

1. Clean sealing surfaces and remove sealant residue.
2. Check bearing for excessive play.
3. Check bearing for abnormal noise when turning the shaft.



77294

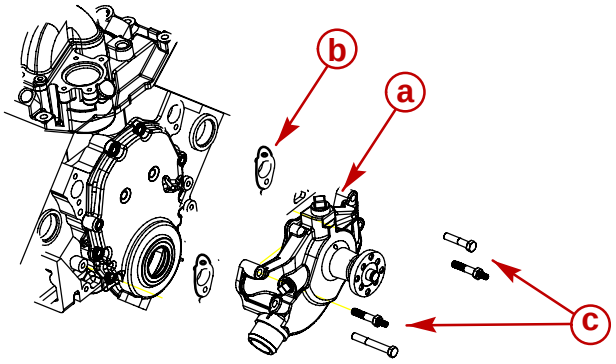
4. Check pump body for cracks.
5. Check seal for signs of leaking at weephole.

Installation

1. Coat both sides of the new water circulating pump gaskets and the threads of the attaching fasteners with sealant.

Description	Where Used	Part Number
Perfect Seal	Water pump fastener	92-34227-1

2. Install new water circulating pump gaskets to the cylinder block.
3. Install the water circulating pump. Torque the bolts.



77954

a - Water circulating pump
b - Gaskets
c - Fasteners

Description	Nm	lb-in.	lb-ft
Water circulating pump fasteners	47.4		35

4. Install the water circulating pump pulley to the water circulating pump. Tighten the bolts securely.
5. Reconnect the hoses to the water circulating pump.
6. Install the serpentine drive belt and adjust the belt tension.
7. Fill the closed cooling system, if equipped.

⚠ CAUTION

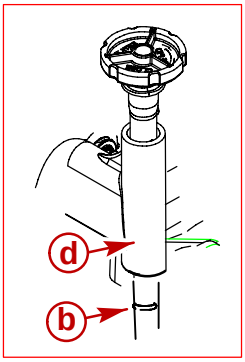
Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

8. Supply cooling water to the engine.
9. Start the engine and check for leaks.

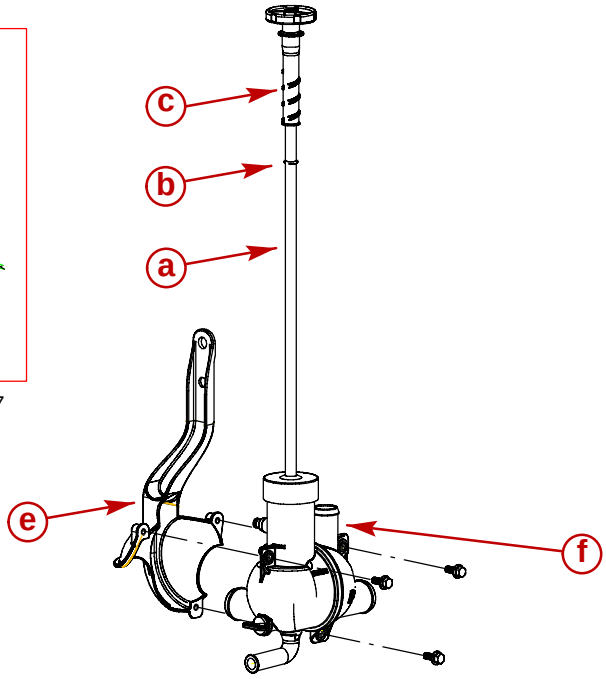
Water Distribution Housing

Removal

1. Drain the seawater section of the cooling system.
2. **On manual single point drain,** remove the drain rod from the water distribution housing.
   a. Remove the C-clip from the drain rod. Retain the C-clip.
   b. Turn the drain rod handle COUNTERCLOCKWISE until the drain rod threads clear the alignment bracket. Pull the drain rod straight up to completely remove.



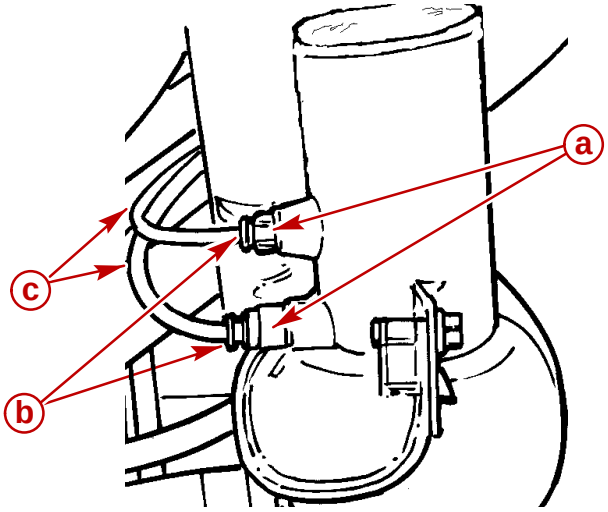
77947



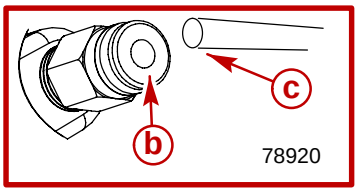
78916

a - Drain rod with blue handle
b - C-clip
c - Drain rod threads
d - Drain rod alignment bracket
e - Bracket for the water distribution housing
f - Water distribution housing assembly

3. **On air actuated single point drain,** remove each air line from the water distribution housing by pressing on the fitting release location and pulling the line out.



77902



a - Air line fitting
b - Release location
c - Air line

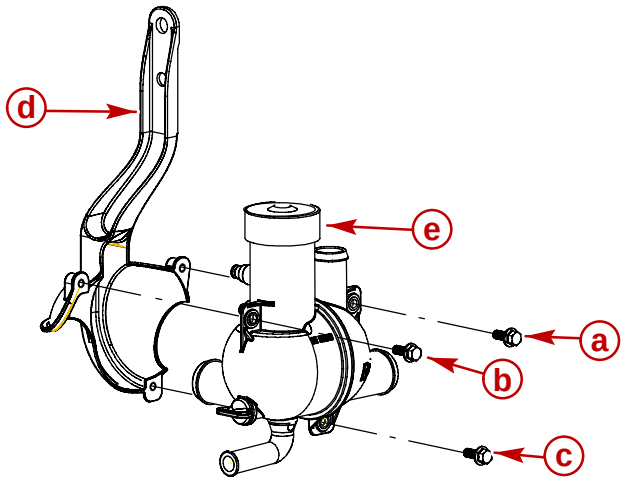
4. Disconnect the hoses from the water distribution housing.
5. Remove the bolt and nut attaching the water distribution housing and bracket to the engine.
6. Remove the bracket from the the water distribution housing.

Cleaning And Inspection

1. Clean the water distribution housing with water and dry with a clean cloth or compressed air.
2. Inspect the housing for leaks, cracks, or corrosion damage. Replace, if necessary.

Installation

1. Align the water distribution housing with the bracket.
2. Install and tighten the screws in the order listed.
   a. Top right-hand side screw.
   b. Top left-hand side screw.
   c. Bottom side screw.
3. Torque the screws in the same order.



78916

a - Top right-hand side screw
b - Top left-hand side screw
c - Bottom side screw
d - Bracket for the water distribution housing
e - Water distribution housing assembly

Description	Nm	lb-in.	lb-ft
Water distribution housing to bracket screws	13	120	

4. Install the bracket and water distribution housing to the engine. Finger-tighten the bolt and nut.

5. **On manual single point drain:**

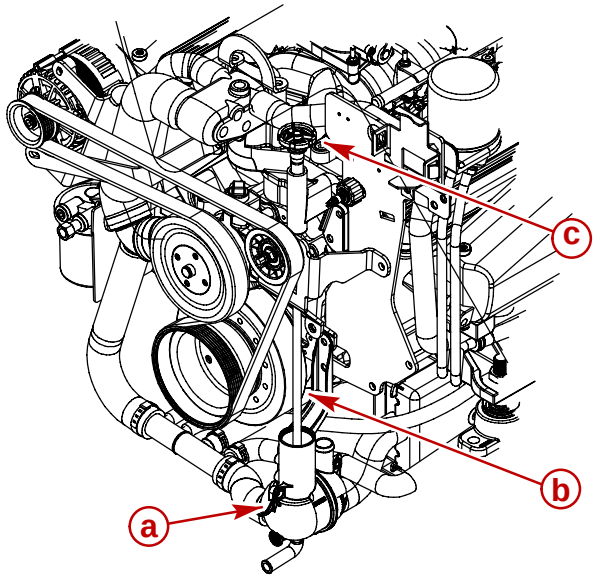
   a. To obtain correct alignment, leave the hoses disconnected from the water distribution housing during installation.

   b. Position the water distribution housing assembly to align with drain rod.

   c. Engage the drain rod into the water distribution housing to complete alignment.

   d. Ensure that the rod is correctly aligned. The rod must screw in and out of the water distribution housing easily and with little pressure.

   e. Install C-clip to drain rod.



77932

a - Water distribution housing
b - Drain rod
c - Drain rod handle

6. Torque the bolt and nut attaching the water distribution housing bracket to the engine.

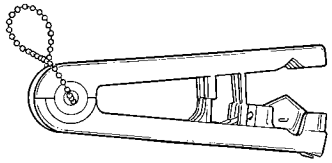
Description	Nm	lb-in.	lb-ft
Water distribution housing bracket bolt and nut	37.9		28

7. **On air actuated single point drain,** install the air lines to the air manifold.

IMPORTANT: Ensure that the air lines are routed to avoid sharp bends and/or contact with moving parts.

NOTE: *The air line must remain cylindrical. The air line must not be distorted when cut. There is a 1 mm (0.04 in.)maximum allowable angle on the end of the air lines*

a. Using the air line cutter, cut the bulk air line to the appropriate length for installation.

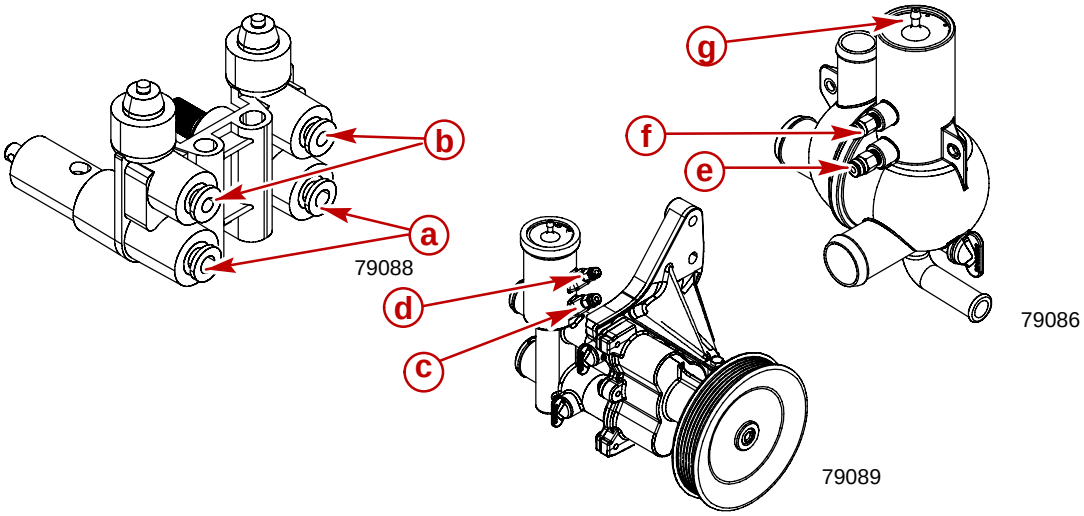
Air Line Cutter		
 79013	Prevents collapsing when cutting the air lines for the water drain system on Mercury MerCruiser models equipped with the air actuated water drain system.	91-883502

b. Connect the air lines from the air manifold assembly to the seawater pump connectors and the water distribution housing connectors by inserting the end of the air line onto the connector approximately 6 mm (1/4 in.).

c. Connect the gray 3/16 in. OD air lines into the lower connectors on the air manifold, the water distribution housing, and the seawater pump.

d. Connect the green 5/32 in. OD air lines into the upper line connectors on the air manifold, the water distribution housing, and the seawater pump.

e. Connect the black 5/16 in. OD vent tube onto the water distribution housing air actuator; secure with tie straps provided.



a - Lower air manifold assembly air line connector 3/16 in.
b - Upper air manifold assembly air line connector 5/32 in.
c - Lower seawater pump air actuator air line connector 3/16 in.
d - Upper seawater pump air actuator air line connector 5/32 in.
e - Lower water distribution housing air actuator air line connector 3/16 in.
f - Upper water distribution housing air actuator air line connector 5/32 in.
g - Vent tubing connection 5/16 in.

8. Ensure that each air line is securely connected by pulling on the line.
9. Secure the air lines using tie straps.
10. Reconnect the hoses to the water distribution housing. Tighten the hose clamps securely.

COOLING SYSTEM

Section 6B - Seawater Cooled Models

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6 B

Specifications

Seawater Cooling System Capacity

Engine	Liter (U.S. Quart)
Seawater cooled models	20 (21)

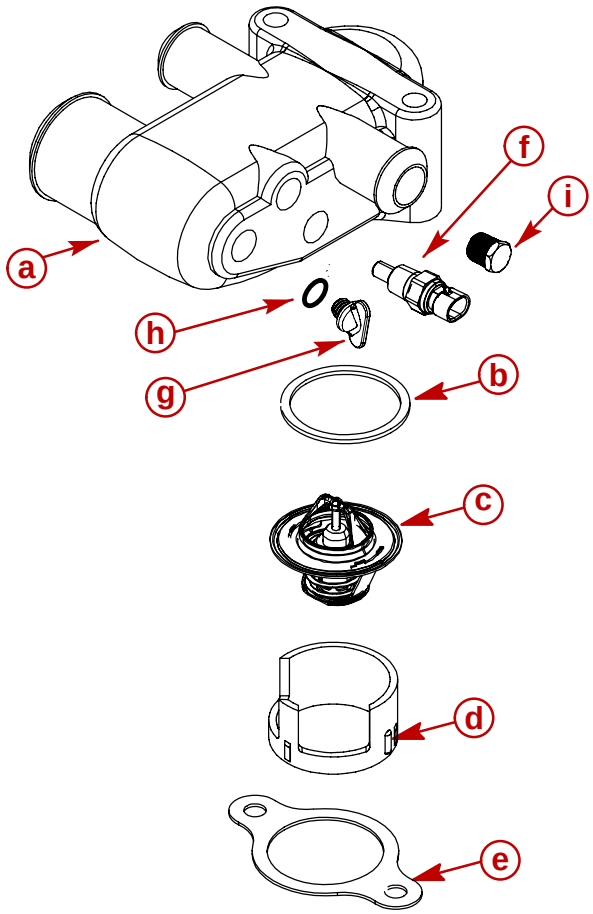
Thermostat

Engine	Specification
Seawater cooled models	71 Degrees C (160 Degrees F)

Exploded View Of Thermostat Assembly

7 Point Manual Drain Systems

Description	Serial Number
Carbureted MCM models	0M599999 and Below
Carbureted MIE models	0M316999 and Below

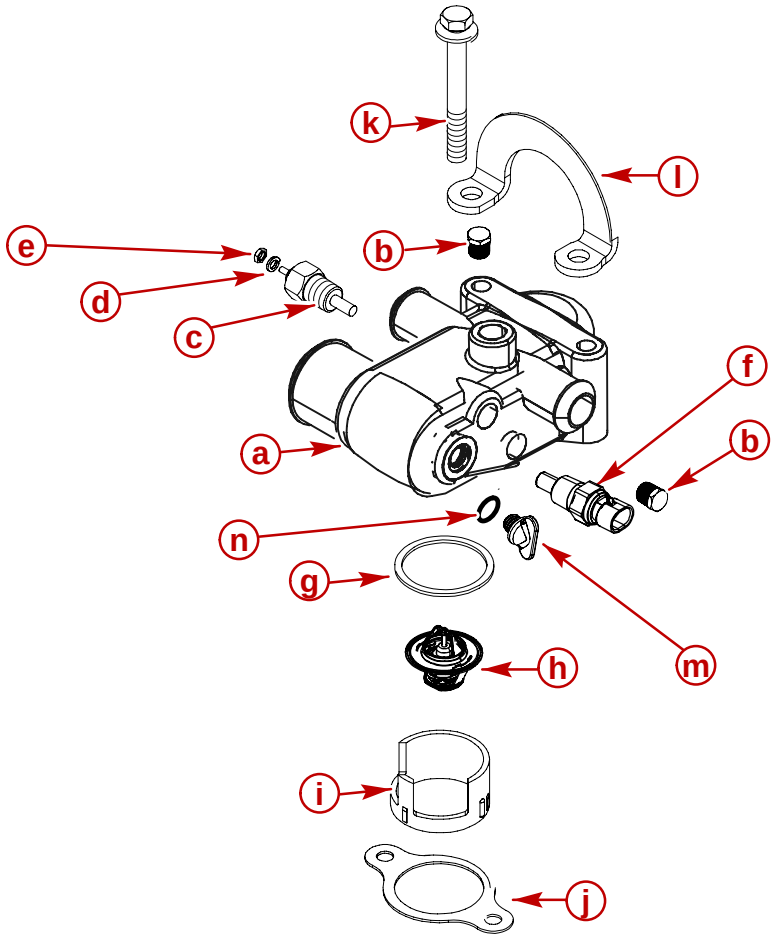


77816

a - Housing
b - Gasket
c - Thermostat (stainless steel)
d - Sleeve
e - Gasket
f - Temperature sensor
g - Air vent plug (for use when draining seawater)
h - O-ring
i - Pipe plug

MPI Single Point And Manual Three Point Drain Systems

Description	Serial Number
MPI MCM Models	0M600000 and Above
MPI MIE Models	0M310000 and Above

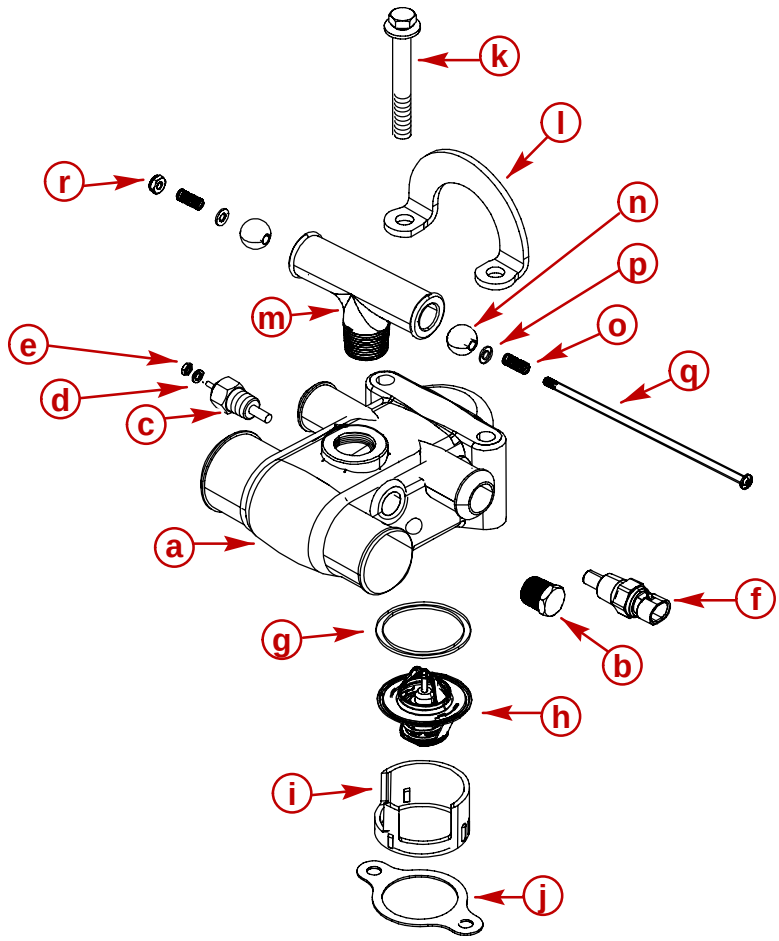


a - Thermostat housing
b - Pipe plug (2)
c - Water temperature sender
d - Lockwasher
e - Nut
f - Temperature sensor
g - Thermostat gasket
h - Thermostat
i - Thermostat sleeve
j - Thermostat housing gasket to intake
k - Screw (2)
l - Lifting eye
m - Air vent plug (for use when draining seawater)
n - O-ring

Multi-Point And 7 Point Drain Systems

Description	Serial Number
MPI MCM models	0M600000 and Above
Carbureted MCM models	0M600000 and Above
Carbureted MIE models	0M317000 and Above

NOTE: *The T-fitting is similar to Scorpion models, but cannot be interchanged due to machining difference.*

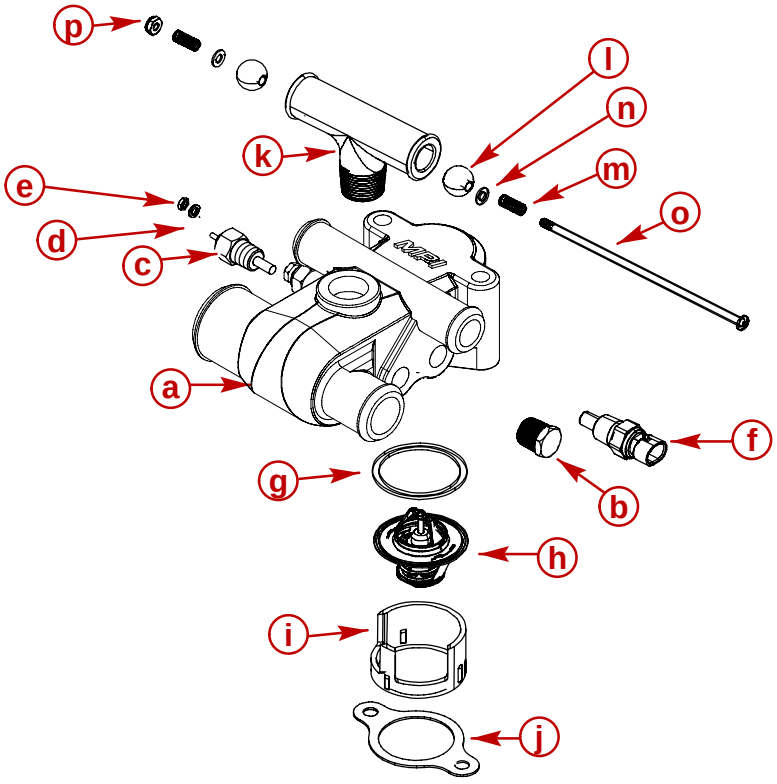


a - Thermostat housing
b - Pipe plug
c - Water temperature sender
d - Lockwasher
e - Nut
f - Temperature sensor
g - Thermostat gasket
h - Thermostat
i - Thermostat sleeve
j - Thermostat housing gasket to intake
k - Screw (2)
l - Lifting eye
m - T-fitting
n - Check ball (2)
o - Spring (2)
p - Washer (2)
q - Screw
r - Locknut

Scorpion

Description	Serial Number
Black Scorpion	0M391600 and Above
MX 6.2 Black Scorpion	0M391750 and Above

NOTE: *The "MPI" identifies machined tolerances to the Scorpion engine models allowing clearance of the T-fitting and the plenum.*



a - Thermostat housing ("MPI")
b - Pipe plug
c - Water temperature sender
d - Lockwasher
e - Nut
f - Temperature sensor
g - Thermostat gasket
h - Thermostat
i - Thermostat sleeve
j - Thermostat housing gasket to intake
k - T-fitting
l - Check ball (2)
m - Spring (2)
n - Washer (2)
o - Screw
p - Locknut

Torque Specifications

Multi-Point Drain Systems

Description	Nm	lb-in.	lb-ft
Thermostat housing to intake manifold screws	41		30

Later Models With Single Point And Manual Three Point Drain Systems

Description	Nm	lb-in.	lb-ft
Thermostat housing to intake manifold screws	33		24

Flushing Seawater Cooling System

Refer to **Section 1B - Maintenance**.

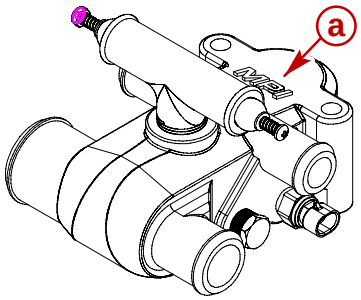
Thermostat Assembly

Identification

Visual identification of the later model multi-point drain system thermostat housings with the T-fitting assembly is determined by the logo on each casting.

SCORPION MODELS 0M391600 AND ABOVE

NOTE: *The “MPI” identifies machined tolerances for the Scorpion engine models allowing clearance between the T-fitting and the plenum.*



79292

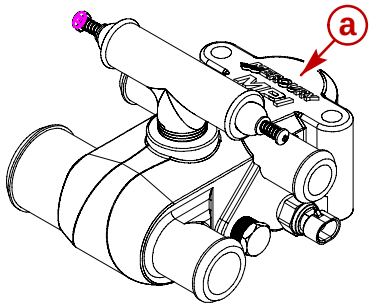
a - Casting identification “MPI”

MPI MODELS 0M600000 AND ABOVE

⚠ CAUTION

Overheating can occur if the thermostat is not in the proper location. The MPI thermostat housing must be used only on MPI models due to machining differences.

NOTE: *The "Mercury MPI" identifies machined tolerances for the engine models equipped with the MPI intake manifolds.*

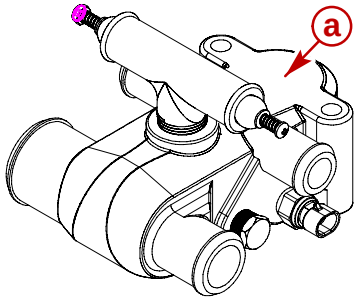


79292

a - Casting identification "Mercury MPI"

CARBURETED MCM MODELS 0M600000 AND ABOVE / MIE MODELS 0M317000 AND ABOVE

NOTE: *No marking identifies machined tolerances for carbureted V8 engine models.*

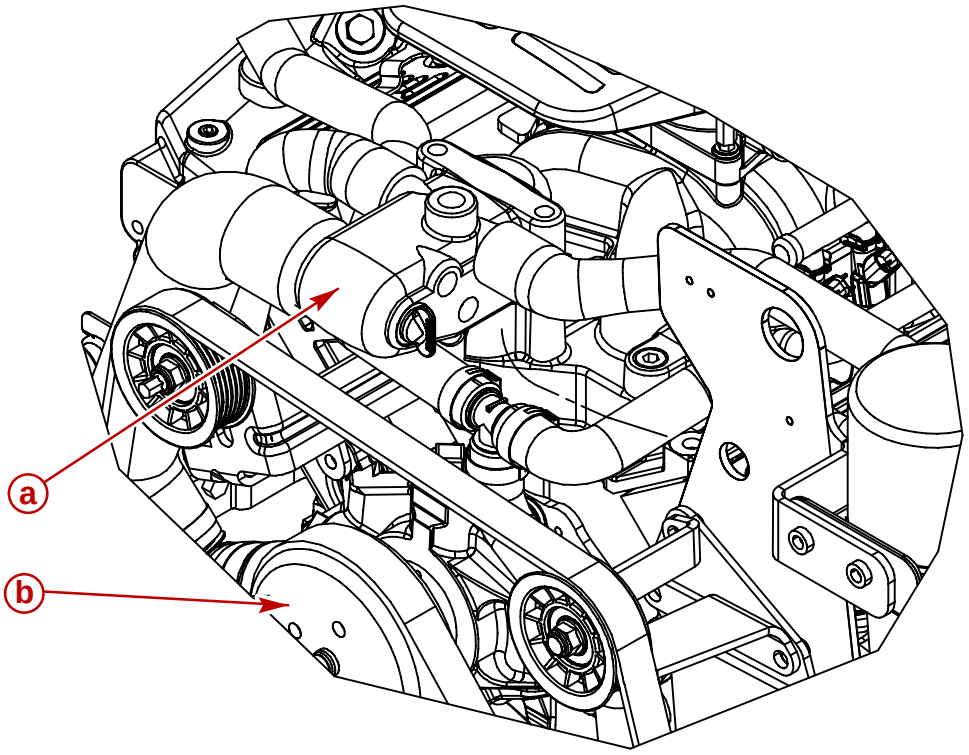


79292

a - Casting identification

Removal

1. Drain the seawater from the engine.
2. Remove the hoses from the thermostat housing.
3. Remove the thermostat housing assembly.
4. Remove the sleeve, thermostat, and gasket from the thermostat housing.



78692

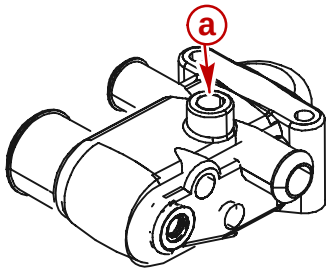
Typical thermostat housing assembly, all models similar

a - Thermostat assembly (lifting eye bracket not shown)
b - Engine water circulating pump

Inspection

THERMOSTAT FOR SINGLE POINT AND MANUAL THREE POINT DRAIN

1. Check that the 2 air vent holes of the thermostat housing casting are not blocked.



78907

a - Air vent holes location (inside raised area)

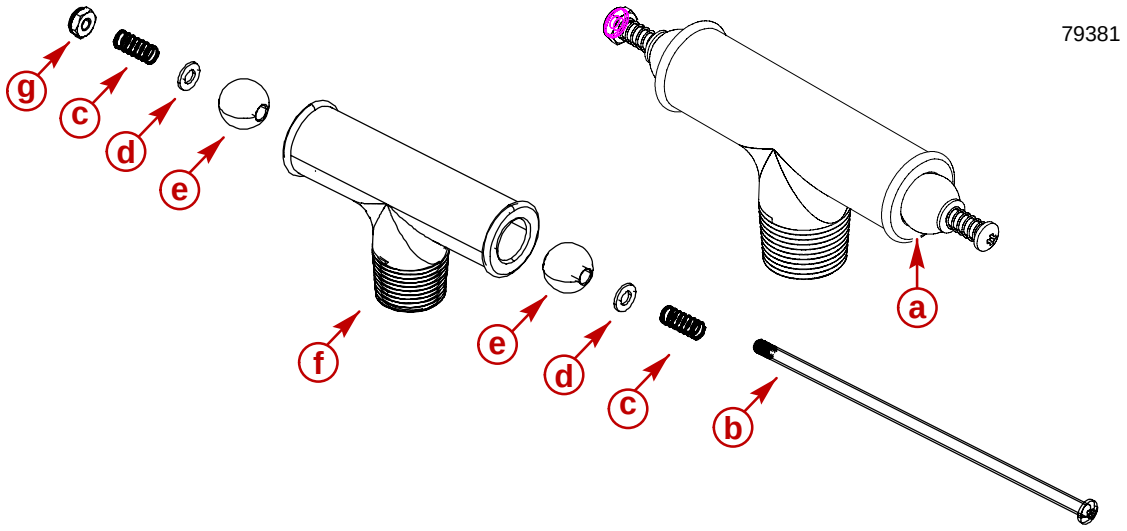
THERMOSTATS WITH T-FITTING

IMPORTANT: Prevent engine overheating. The T-fitting spring tension must be adequate to seat check balls.

2. Inspect the check balls for proper seating to the T-fitting. If both check balls are not taut against the T-fitting, the springs should be replaced.

IMPORTANT: Replace the check balls and the springs of the T-fitting if engine overheats.

3. Remove the T-fitting nut and components.
4. Inspect the check balls of the T-fitting assembly for grooves, roundness, and worn areas. Replace if damaged.
5. Reassemble components in order of removal. Secure with nut.



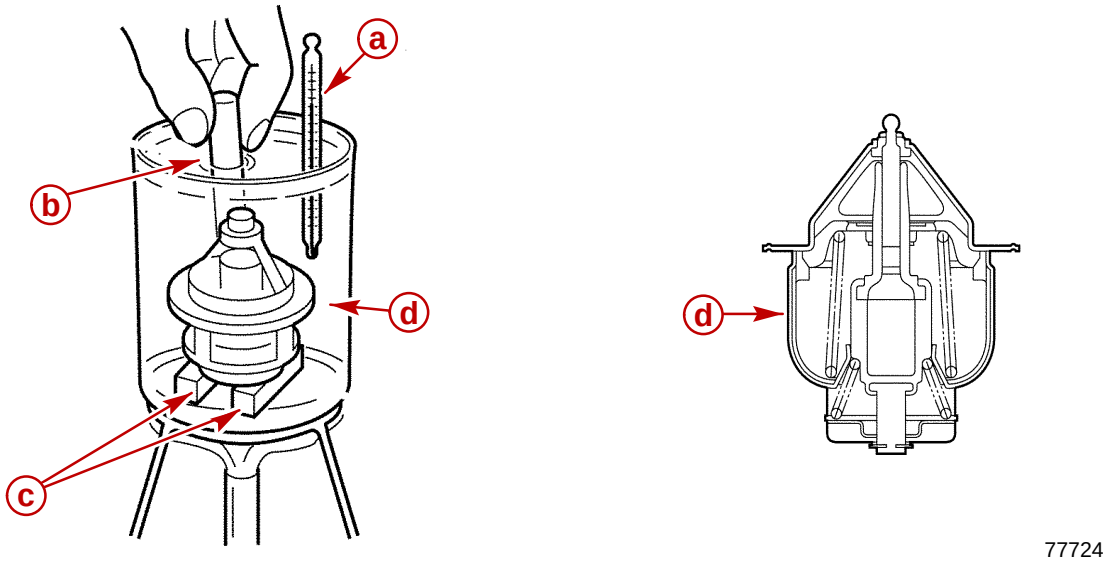
79381

Typical T-fitting assembly

a - Check ball to T-fitting location
b - Screw
c - Spring
d - Washer
e - Check ball
f - T-fitting
g - Nut

Testing

1. Remove the thermostat.
2. Place the thermostat on blocks in a container.
3. Completely submerge the thermostat in water.
4. Heat the water.
5. Stir the water constantly to avoid direct heat being applied to the thermostat.
6. Refer to Specifications:
   a. Check the thermostat initial opening temperature.
   b. Check the thermostat full opening temperature.
   c. Check valve lift at fully open position.



77724

Typical thermostat

a - Thermometer
b - Agitating Rod
c - Wooden Blocks
d - Thermostat

7. Replace if specifications are not met or damage is discovered during inspection.

Installation

NOTE: *Refer to exploded view preceding for parts identification during assembly.*

1. Clean the gasket surfaces inside the thermostat housing, on the thermostat housing, and on the intake manifold.
2. Place a new thermostat gasket in the thermostat housing. Ensure that it is positioned properly in the housing.
3. Place the thermostat in the thermostat housing with the thermostatic element end toward the housing bottom.
4. Align the sleeve with the groove in the thermostat housing bore and install the sleeve into the housing.
5. Position a new thermostat housing gasket on the intake manifold.
6. Install the thermostat housing and torque the screws.

Description	Nm	lb-in.	lb-ft
Thermostat housing screws	41		30

7. Reconnect the hoses to the thermostat housing. Tighten the hose clamps securely.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

8. Supply cooling water to the engine.
9. Start the engine and inspect for leaks.

T-Fitting For Water Hose Assembly

Visual identification of the orifice bushing is the colored O-ring on the lower leg of the T-fitting. Models that require the T-fitting without the orifice bushing do not use the colored O-ring.

⚠ CAUTION

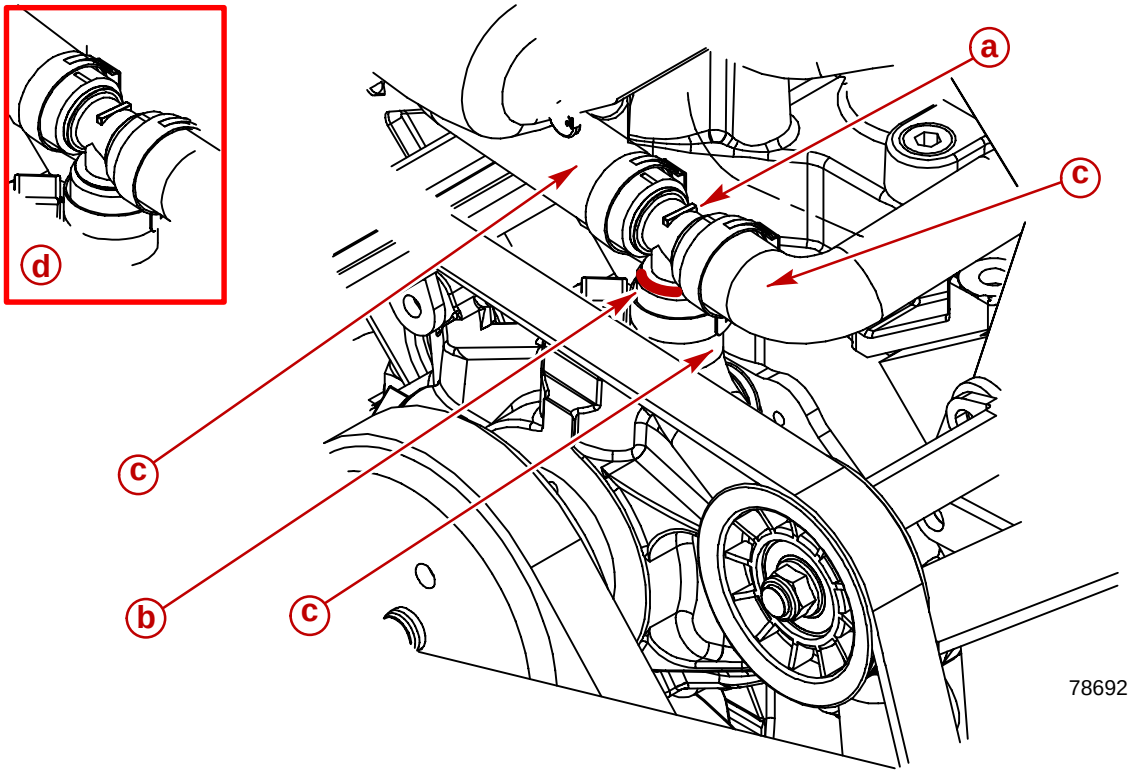
Overheating can occur if the orifice bushing is not installed.

IMPORTANT: Orifice bushing and O-ring are for use on seawater cooled Alpha models only. Do not use on Bravo models.

NOTE: *The friction from the water distribution housing to T-fitting hose will retain the orifice bushing.*

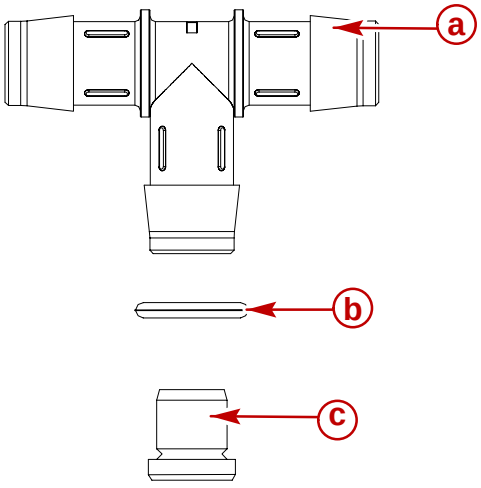
Removal

1. Remove hose clamps.
2. Disconnect the water hoses from the T-fitting.



a - T-fitting with orifice bushing (Alpha seawater cooled models)
b - O-ring (Alpha seawater cooled models)
c - Water hose
d - T-fitting without orifice bushing or O-ring (Bravo models)

3. **Alpha models with orifice bushing:** Remove orifice bushing and O-ring from T-fitting.



Rear view of T-fitting

a - T-fitting
b - O-ring
c - Orifice bushing

Cleaning And Inspection

1. Clean with soapy water.
2. Inspect the T-fitting, orifice bushing, and O-ring, if equipped, for damage.
3. Replace any damaged parts.

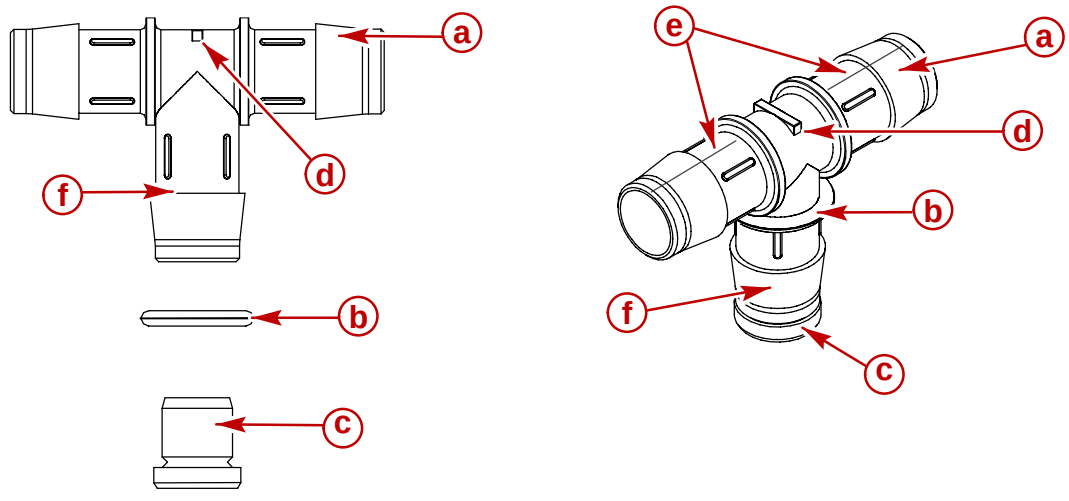
Assembly

ALPHA MODELS

⚠ CAUTION

Overheating can occur if the orifice bushing is not installed.

1. Install the orifice bushing into the lower leg of the T-fitting.
   a. Place the O-ring onto the lower leg of the T-fitting.



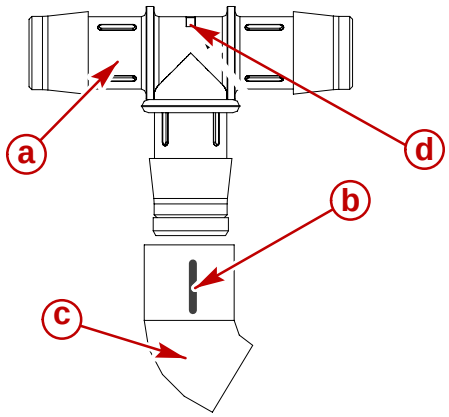
78984

Rear view of T-fitting

- **a** - T-fitting
- **b** - O-ring
- **c** - Orifice bushing
- **d** - Alignment feature (molded onto top of T-fitting)
- **e** - Parting line (top of T-fitting)
- **f** - Lower leg of T-fitting

2. Align the marks on the hose to the alignment feature on the top of the T-fitting.

3. Install the T-fitting into the hose. Tighten the hose clamp securely.

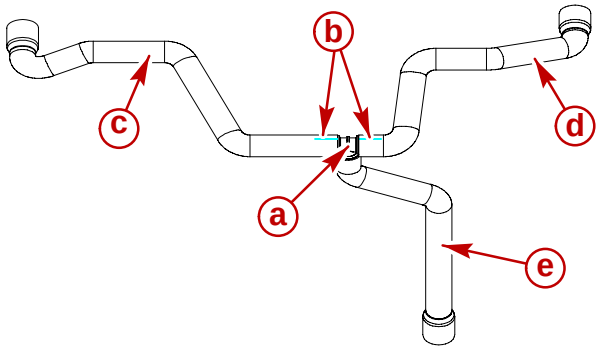


78985

Rear view of hose assembly

- **a** - T-fitting
- **b** - Alignment marks (on hose)
- **c** - Water distribution housing to T-fitting hose
- **d** - Alignment feature (molded onto top of T-fitting)

4. Align the marks on the hoses to the parting line on the T-fitting. Install the T-fitting to port and starboard elbow hoses onto the T-fitting.
5. Tighten the hose clamps securely.



78985

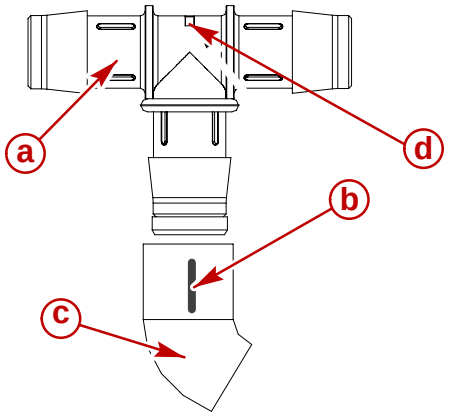
- **a** - T-fitting
- **b** - Alignment marks (on hose)
- **c** - T-fitting to starboard elbow hose
- **d** - T-fitting to port elbow hose
- **e** - Water distribution housing to T-fitting hose

IMPORTANT: Ensure that the hoses are routed properly to avoid contact with rotating components.

6. Route the water distribution housing to T-fitting hose down through the tensioner pulley bracket and connect it to the water distribution housing.
7. Connect the T-fitting to port elbow hose to the hose fitting on the port exhaust elbow.
8. Connect the T-fitting to starboard elbow hose to the hose fitting on the starboard exhaust elbow.
9. Tighten all the hose clamps securely.
10. Ensure that the O-ring is visible on the lower leg of the T-fitting.

BRAVO MODELS

1. Align the marks on the hose to the alignment feature on the top of the T-fitting.
2. Install the T-fitting into the hose. Tighten the hose clamp securely.

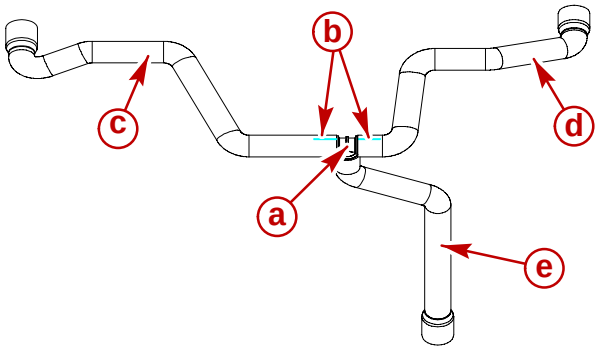


78985

Rear view of hose assembly

- **a** - T-fitting
- **b** - Alignment marks (on hose)
- **c** - Water distribution housing to T-fitting hose
- **d** - Alignment feature (molded onto top of T-fitting)

3. Align the marks on the hoses to the parting line on the T-fitting. Install the T-fitting to port and starboard elbow hoses onto the T-fitting.
4. Tighten the hose clamps securely.



78985

- **a** - T-fitting
- **b** - Alignment marks (on hose)
- **c** - T-fitting to starboard elbow hose
- **d** - T-fitting to port elbow hose
- **e** - Water distribution housing to T-fitting hose

IMPORTANT: Ensure that the hoses are routed properly to avoid contact with rotating components.

5. Route the water distribution housing to T-fitting hose down through the tensioner pulley bracket and connect it to the water distribution housing.
6. Connect the T-fitting to port elbow hose to the hose fitting on the port exhaust elbow.
7. Connect the T-fitting to starboard elbow hose to hose fitting on starboard exhaust elbow.
8. Tighten all the hose clamps securely.

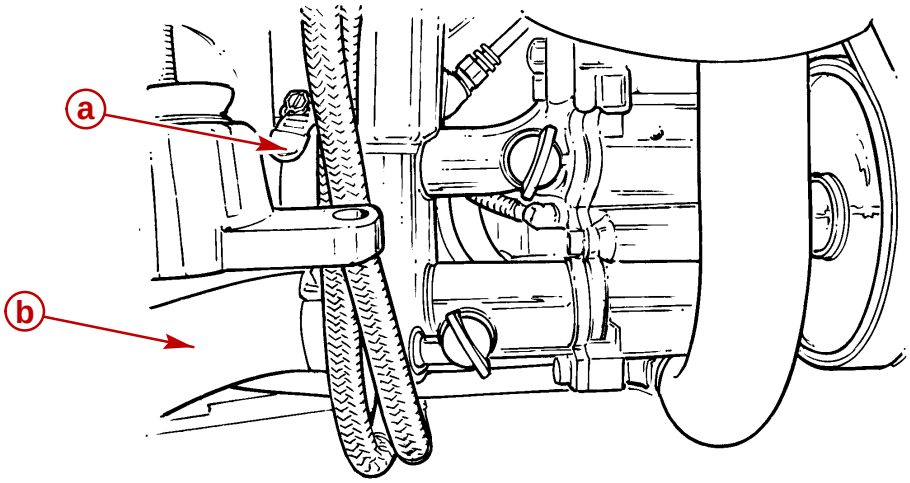
Seawater Pump Output Test

If an overheating problem exists, use this test to determine if a sufficient amount of water is being supplied to cool the engine.

IMPORTANT: The following information should be observed before proceeding with the test:

- **THE BOAT MUST BE IN THE WATER FOR THIS TEST. This test CANNOT BE performed with a flush-test device and water hose.**
- **The ability of this test to detect a problem is greatly dependent upon the accuracy with which it is performed. An error in setting the engine rpm, timing the test or measuring the water output will affect the overall accuracy of the test and may produce misleading results. To help ensure accurate results, use a shop tachometer with an error of less than 5 percent. Definitely do not use the boat tachometer as it may not have the necessary precision. Use a stop watch to time the duration of the test to help ensure that the accuracy is maintained within one second. Use a 9.5 liter (10 U.S. qt) or larger capacity container to measure the water output.**
- **Due to the manner in which this test is performed, it may not be possible to detect a marginal condition or a high-speed water pump output problem.**

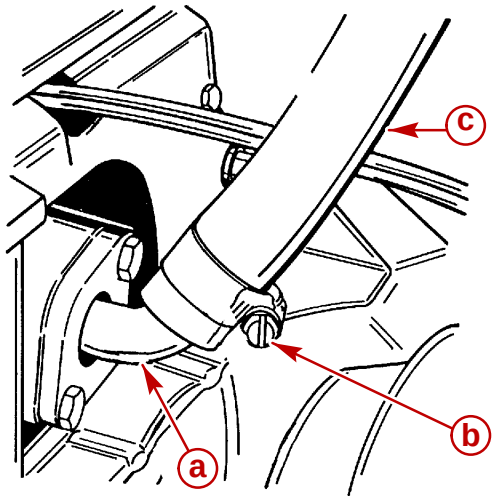
1. **Models With Engine Mounted Seawater Pump,** remove the water hose that is between the pump outlet and the engine, and replace with another hose of the same diameter, but approximately 1 m (3 ft) longer. The hose should be of adequate wall thickness to prevent it from kinking when performing the test. Clamp the hose at the pump outlet only. Do not clamp the hose at the engine cooler end.



77908

a - Seawater inlet hose
b - Seawater outlet hose to cooler

2. **Models With Sterndrive (Alpha) Mounted Seawater Pump,** remove the water inlet hose, which is between the gimbal housing water tube and the engine, and replace with another hose of the same diameter, but approximately 1 m (3 ft) longer. The hose should be of adequate wall thickness to prevent it from kinking when performing the test. Clamp the hose at the gimbal housing water tube only. Do not clamp the hose at the engine end.



72614

a - Water tube
b - Hose clamp
c - Water hose

3. Place a 9.5 liter (10 U.S. qt) or larger container near the unclamped end of the hose.

4. With the assistance of another person, start the engine and adjust the speed to exactly 1000 rpm while holding the unclamped end of the hose on the connection on the engine. Remove the hose from the connection on the engine and direct the water flow into the container for exactly 15 seconds. At the end of 15 seconds, direct the water flow overboard, return the engine to idle and stop the engine. Reconnect the hose to the engine.
5. Measure the quantity of water discharged into the container and compare with the specifications given in the following chart.
6. Repeat the test four times to check the repeatability of the results.

NOTE: *Values listed are70% of the nominal flow at 1000 rpm.*

Engine Mounted Seawater Pump Output For A 15 Second Period	
Drive Unit	**Minimum Quantity Liter (U.S. Qt.)**
Bravo seawater cooled engine	7.1 (7.5)
Bravo closed cooled engine and external water pick up	9.0 (9.5)
All inboard and tow sport models	9.0 (9.5)

Alpha Sterndrive Seawater Pump Output For A 15 Second Period	
Drive Unit	**Minimum Quantity Liter (U.S. Qt.)**
Alpha models	4.7 (5.0)

COOLING SYSTEM

Section 6C - Closed Cooled Models

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6C

Specifications

Seawater Inlet Recommendations

Description	Specification
Minimum flow	114 liter/min (30 gal/min) at 4000 rpm
Minimum pressure at full flow[1]	138 kPa (20 psi) at 4000 rpm

[1] *If restrictions are present, the reading could be inaccurate.*

Closed Cooling System Capacity

NOTE: *All capacities are approximate fluid measures.*

MCM MODELS 0M599999 AND BELOW / MIE MODELS 0M316999 AND BELOW

One-half Closed Cooled System	Liters (U.S. Qts)
Closed Cooling System	19 (20)

MCM MODELS 0M600000 AND ABOVE / MIE MODELS 0M317000 AND ABOVE

Full Closed Cooled System	Liters (U.S. Qts)
Coolant volume in engine, heat exchanger, and exhaust	19.47 (20.5)
Seawater volume in conduits and tube side of heat exchanger	4.3 (4.5)

Coolant Specification

Description	Part Number
Extended Life Coolant 5/100 (Orange Color)	92-877770K1

Thermostat

MCM MODEL 0M599999 AND BELOW / MIE MODEL OM316999 AND BELOW (WET JOINT)

Description	Specifications
One-half closed cooled system	71 Degrees C (160 Degrees F)

MCM MODEL 0M600000 AND ABOVE / MIE MODEL OM317000 AND ABOVE (DRY JOINT)

Description	Specifications
Full closed cooled system	77 Degrees C (170 Degrees F)

Pressure Cap Rating

Engine	Specifications
All engines	110 kPa (16 psi)

Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Perfect Seal	Heat exchanger end cap gaskets	92-34227-1

Torque Specifications

MCM Model 0M599999 And Below / MIE Model 0M316999 And Below

NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb-in.	lb-ft
Heat exchanger end cap	6	54	
Thermostat cover screw	41		30

MCM Models 0M600000 And Above / MIE Models 0M317000 And Above

NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb-in.	lb-ft
Heat exchanger end cap	12	108	
Thermostat cover screw	30		22
Thermostat housing to intake screw	33		24
Air manifold to heat exchanger screw	3	27	
Hose clamps around heat exchanger and bracket	3	26	

General Information

NOTE: *Some engines may have been converted from wet joint to dry joint by using separately ordered kits. Visually identify your engine rather than relying solely on serial number breaks.*

Full Loop

Engine models covered in this section are considered a full closed cooling system. The term full closed cooling system, also known as full fresh water cooled or full FWC refers to the use of ethylene glycol mixture in the engine and the exhaust water jackets.

1/2 Loop

Engine models in service manuals number 24, 25, and 32 are 1/2 closed cooling systems or 1/2 systems. The term 1/2 closed cooling system refers to the use of ethylene glycol mixture in the engine cooling passages and the use of seawater in the exhaust water jackets.

Description

The cooling system is composed of two separate subsystems: the seawater system and the closed cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat from the closed cooling system as it passes through the heat exchanger. The closed cooling system is similar in function to the rest of the cooling system in an automobile.

The coolant recovery system keeps the reservoir full. Normal coolant overflow into the recovery bottle is approximately 230 ml (1/2 pint) during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. As long as there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there is a vacuum leak, usually at the hose leaving the reservoir or the gasket under the recovery filler cap.

IMPORTANT: The coolant (antifreeze) flows around the outside of the cooling tubes while seawater flows through the inside of the cooling tubes in the heat exchanger.

Coolant Recommendations

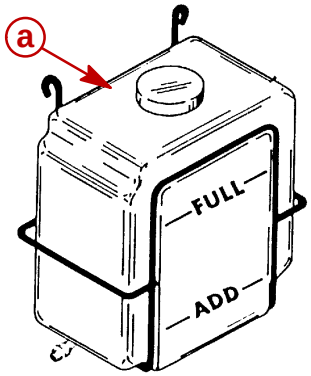
⚠ CAUTION

Alcohol or Methanol base antifreeze or plain water are not recommended for use in the fresh water section of cooling system at any time.

NOTE: *All factory installed closed cooling systems come filled with Extended Life Coolant. This antifreeze requires draining and replacing every five years or 1000 hours of operation, whichever comes first. For best results any top-off fluid used should be Extended Life Coolant. If Extended Life Coolant is unavailable, any type of ethylene glycol based antifreeze may be used, but it will require the draining and replacing of the coolant every two years or 400 hours of operation, whichever comes first.*

In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Maintaining Coolant Level



72520

Coolant recovery bottle

a - Fill cap

1. Before starting the engine each day, ensure that the coolant is visible in the coolant recovery bottle.
2. If the coolant is not visible, check the closed cooling system (including the coolant recovery system) for leaks and repair.
3. Refill with the recommended coolant solution as outlined under Changing Coolant.
4. If the coolant is visible, start the engine and operate until it reaches normal operating temperature, then recheck the coolant level in the coolant recovery bottle. The coolant level MUST be between the ADD and FULL marks on the front of the bottle.

⚠ WARNING

Allow the engine to cool before removing the pressure cap. A sudden loss of pressure could cause the hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn to allow any pressure to escape slowly, then push down and remove the cap.

5. If the level is low, remove the fill cap from the coolant recovery bottle and add the required amount of coolant solution. Refer to Coolant Recommendations in this section.
6. Occasionally, ensure that the coolant recovery system is functioning properly by removing the pressure cap from the heat exchanger and checking the level. The coolant level should be up to the bottom of the heat exchanger filler neck. If low, examine the entire closed cooling section (especially the coolant recovery system) for leaks and repair.

IMPORTANT: When reinstalling the pressure cap, tighten it until it contacts the stops on the filler neck.

7. Select a mounting location for coolant recovery bottle and mounting bracket that meets all of the following:

- Within limits of clear plastic tubing.
- Level with or above the heat exchanger fill neck.
- Accessible for observing coolant level and filling.

Pressure Cap Maintenance

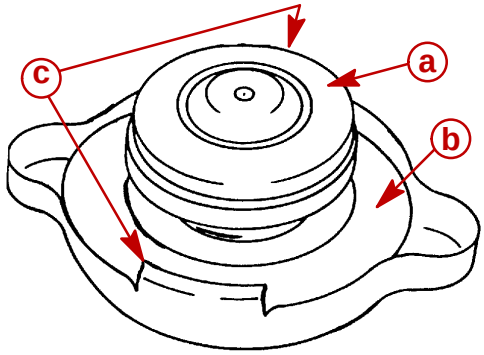
The pressure cap should maintain pressure the closed cooling system at normal engine operating temperature. This raises the boiling point of the coolant, thereby increasing the efficiency of the cooling system. To help ensure proper operation, the cap should be cleaned, inspected and pressure tested periodically.

⚠ WARNING

Allow the engine to cool before removing the pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn to allow any pressure to escape slowly, then push down and turn the cap all the way off.

1. Remove the pressure cap from the heat exchanger.
2. Wash the cap with clean water to remove any deposits or debris from the sealing surfaces.
3. Inspect the rubber seal on the cap for cuts, cracks, or other signs of deterioration. If the seal is damaged, the cap MUST be replaced.
4. Inspect the gasket for deterioration and replace if necessary.
5. Check the condition of the locking tabs on the cap. Replace the cap if the tabs are bent or cracked.
6. Check the gasket for cracks or other damage.

IMPORTANT: The pressure cap must be replaced if damaged. If engine has overheated for any reason, the pressure cap must be replaced.

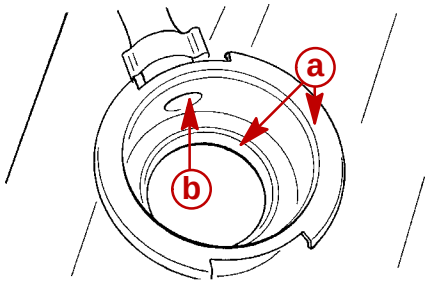


72714

a - Rubber seal
b - Gasket
c - Locking tabs (1 not shown)

7. Test the pressure cap.
8. Clean the sealing surfaces on the heat exchanger filler neck with a cloth. Inspect the surfaces for any damage or deposits that may prevent the cap from sealing properly.

9. Clean the coolant recovery passage in the heat exchanger filler neck with a wire and blow out with compressed air.



72715

a - Sealing surfaces
b - Coolant recovery passages

10. Reinstall the pressure cap. Tighten the cap until it contacts the filler neck.

Testing Closed Cooling System

Testing Coolant for Alkalinity

⚠ WARNING

Allow the engine to cool before removing the pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn to allow any pressure to escape slowly, then push down and turn the cap all the way off.

The coolant should be changed per the Maintenance Schedule recommendations and should be checked for alkalinity at least once between change intervals. To check the coolant for alkalinity, proceed as follows:

1. Obtain pink litmus paper from a local source.
2. Allow the engine to cool and remove the pressure cap from the heat exchanger and insert one end of the litmus paper into the coolant.
3. **If pink litmus paper turns blue,** the coolant is alkaline and need not be replaced.
4. **If pink litmus paper remains pink,** the coolant is not alkaline and MUST BE REPLACED, as explained under Changing Coolant.

Pressure Testing System

⚠ WARNING

Allow the engine to cool before removing the pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn to allow any pressure to escape slowly, then push down and turn the cap all the way off.

If the coolant section of the closed cooling system is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove the pressure cap from the heat exchanger or the reservoir.
2. Clean, inspect, and pressure test the pressure cap.
3. Clean the inside of the filler neck to remove any deposits or debris.
4. Examine the lower inside sealing surface for damage. The surface must be perfectly smooth to achieve a good seal between it and the rubber seal on the cap.
5. Ensure that the locking cams on the sides of the filler neck are not bent or damaged.
6. Adjust the coolant level to 25 mm (1 in.) below the filler neck.
7. Attach an automotive-type cooling system pressure tester to the filler neck and pressurize closed cooling section to amount specified in following chart.

Pressure Cap Rating	Amount of Pressure Applied to Closed Cooling System
110 kPa (16 psi)	138 kPa (20 psi)

8. Observe the gauge reading for approximately two minutes; the pressure should not drop during this time. If the pressure drops, proceed with the following steps until leakage is found.
9. While maintaining the specified pressure on the closed cooling section, visually inspect the external portion of the cooling system (hoses, gaskets, drain plugs, petcocks, core plugs, circulating pump seal, etc.) for leakage. Also listen closely for bubbling or hissing.
10. Test the heat exchanger.

Seawater Pressure Test

IMPORTANT: This test applies to MPI Closed Cooled models only.

IMPORTANT: The boat should be in the water for this test.

1. Connect an appropriate scan tool to the ALDL connector.
2. Start the engine, when engine is at normal operating tenmperature shift into FORWARD gear and operate the boat as in normal boat operation.
3. Advance the the throttle to 4000 rpm.
4. Measure the seawater pressure. If seawater pressure does not meet specification, plumbing changes will have to be made.

Description	Specification
Minimum pressure (closed cooled models)	20 psi (138 kPa) at 4000 rpm

5. If no leakage could be found in the above steps, the engine is leaking internally. Leaking may be caused by one or more of the following: loose cylinder head bolts or damaged gasket, loose intake manifold bolts or damaged gasket, loose exhaust elbow or distribution block retaining nuts or damaged gasket, cracked or porous cylinder head or block or cracked or porous exhaust manifold. Proceed as follows until the location of the internal leak is found.

   a. Start the engine. Re-pressurize the system to the previously specified amount and observe the pressure gauge on the tester. If the needle in the gauge vibrates, the compression or the combustion is leaking into the closed cooling section from a leak in the combustion chamber. Exact cylinders where the leakage is taking place can sometimes be found by removing the spark plug wires (one at a time) while observing the pressure gauge. Vibration will decrease or stop when the plug wire is removed from the leaking cylinder. Stop the engine.

   b. Remove the spark plugs (one at a time) from the cylinders and examine for the presence of coolant. A spark plug that is perfectly clean or milky appearing is a sure indication of a leak.

   c. Drain the oil from the engine and examine for coolant. Oil will usually be milky if coolant is present. If coolant is present, remove the engine from the boat and drop the oil pan. With the engine in the upright position, re-pressurize the closed cooling section to the previously specified amount and examine the internal surfaces of the engine to locate the leak.

   d. If no leakage can be found in the above steps, the entire engine must be disassembled and inspected for leaks.

Testing For Cylinder Head Gasket Leak

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures that cause the leak. An effective test is as follows:

IMPORTANT: Operate the boat in the water for this test. It is best to operate the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and the coolant recovery bottle. Use a 61-91 cm (2-3 ft) long hose for this test.
2. Route this hose so a U is formed.
3. Put enough coolant into the hose to fill the center 10-13 cm (4-5 in.) of the U-shape.
4. Observe the U-shape while the engine is operating.
    a. **During Idle and Warm-Up:** Some coolant and/or air will leave the reservoir.
    b. **During Cruising Speed (2500-3500 rpm):** Coolant and/or air leaving the reservoir should stop after approximately five minutes operating at a given rpm. A leaking head gasket will produce air bubbling through the U-shape, going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.
    c. **At Higher Speeds (4000+ rpm):** Normal operation is the same as described above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant.

Do not confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant that will stop within approximately five minutes at a given rpm. A head gasket leak will not stop because the one thing that marks a failed head gasket is the continued passage of air. This may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant flows evenly from the reservoir at cruising speed, something other than the head gasket is causing the engine to overheat.

Testing Pressure Cap

IMPORTANT: Replace the pressure cap if the engine overheats.

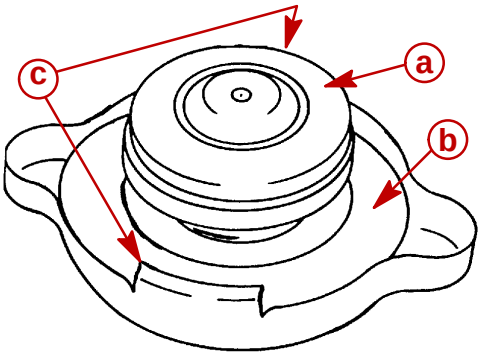
The pressure cap is designed to maintain a pressure of approximately its rated capacity once the engine has attained operating temperature. The cap should be cleaned, inspected and pressure-tested at regular intervals or whenever the cap is suspected of maintaining improper pressure.

⚠ WARNING

Allow the engine to cool before removing the pressure cap. A sudden loss of pressure could cause hot coolant to boil and discharge violently. After the engine has cooled, turn the cap 1/4 turn to allow any pressure to escape slowly, then push down and turn the cap all the way off.

1. Carefully remove the pressure cap from the reservoir or the heat exchanger.
2. Wash the cap with clean water to remove any deposits or debris from the sealing surfaces.
3. Inspect the gasket (if used) and the rubber seal on the cap for tears, cuts, cracks, or other signs of deterioration. Replace the gasket, if damaged.
4. Replace the cap if the rubber seal is damaged.
5. Check the condition of the locking tabs on the cap. Replace the cap if the tabs are bent or cracked.

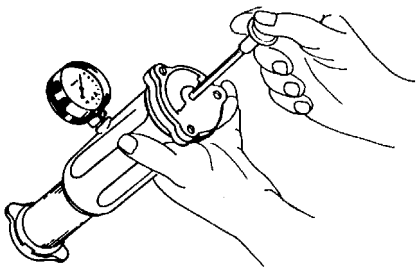
IMPORTANT: The cap must be replaced if damaged.



72714

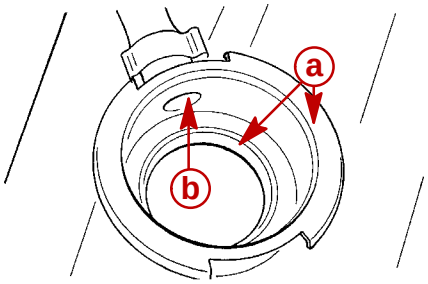
a - Rubber seal
b - Gasket
c - Locking tabs (1 not shown)

6. Using a cooling system pressure tester (similar to one shown), test the cap to ensure that it releases at the proper pressure and does not leak. (Refer to the instructions which accompany the tester for the correct test procedure.) The cap must relieve pressure at 110 kPa (16 psi), and must hold the rated pressure for 30 seconds without going below 75.8 kPa (11 psi). Replace the cap if it fails to fall within these limits.



72716

IMPORTANT: Before reinstalling the cap in the next step, examine the lower inside sealing surface in the filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect the cam lock flanges on the sides of the filler neck to ensure that they are not bent.



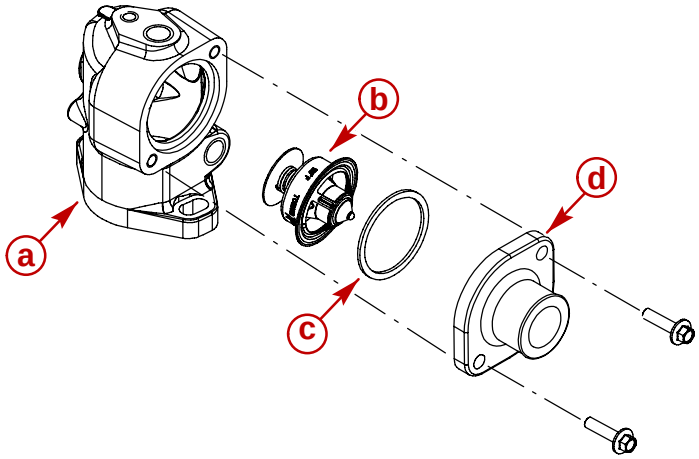
72715

a - Sealing surfaces
b - Coolant recovery passages

7. Reinstall the cap on the reservoir or the heat exchanger.

Thermostat

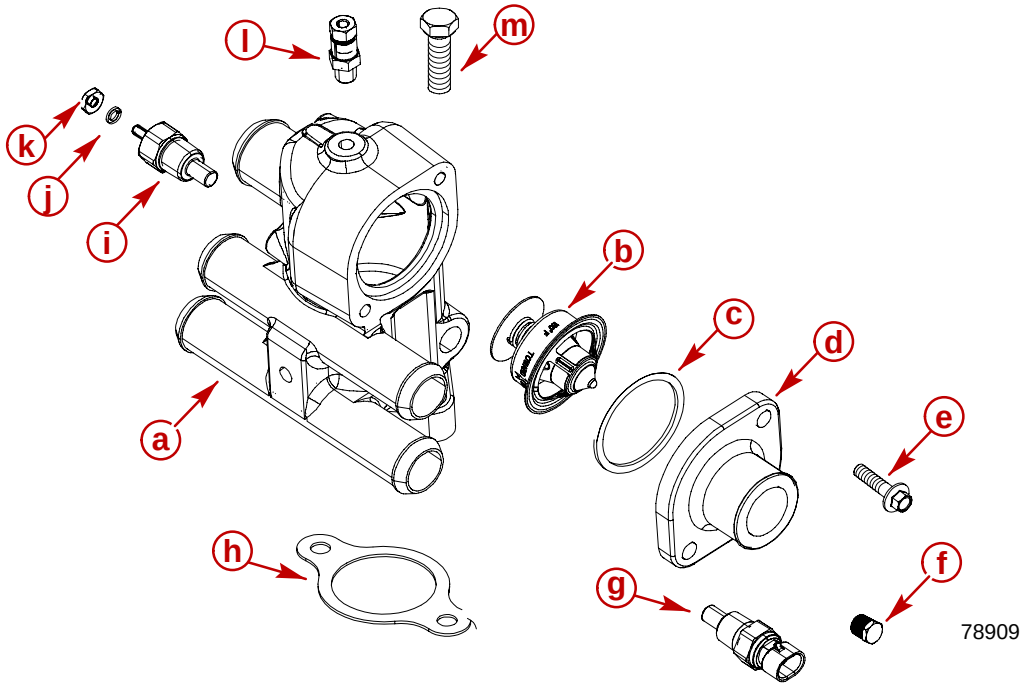
MCM Model 0M599999 And Below / MIE Model 0M316999 And Below



78148

a - Thermostat housing
b - Thermostat
c - Gasket
d - Thermostat housing cover

MCM Models 0M600000 And Above / MIE Models 0M317000 And Above



78909

a - Thermostat housing
b - Thermostat
c - Thermostat seal
d - Thermostat housing cover
e - Thermostat housing cover screw
f - Plug
g - Temperature sensor
h - Gasket
i - Temperature sender
j - Lockwasher
k - Nut
l - Air vent
m - Screw

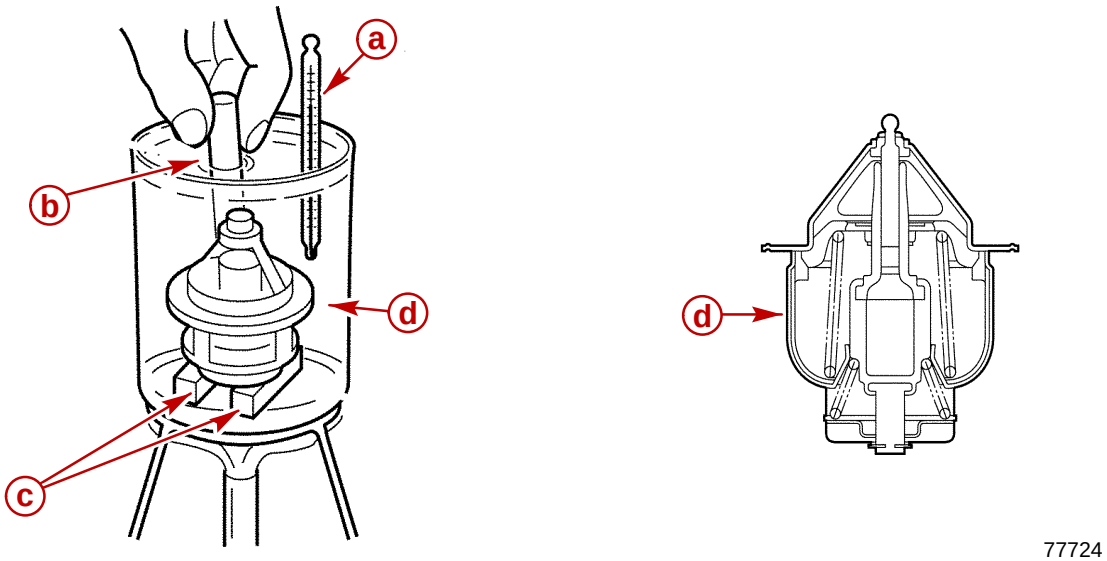
Removal

NOTE: *If the coolant flow is restricted or fails to occur, a wire should be repeatedly inserted into all drain holes to ensure that there are no obstructions in the passages. Remove the fitting, if necessary, to insert the wire completely into the drain hole.*

1. Drain the coolant from the engine.
2. Disconnect the hoses from the thermostat cover.
3. Remove the thermostat cover bolts, the cover, and the gasket.
4. Remove the thermostat from the thermostat housing.

Testing

1. Place the thermostat on blocks in a container.
2. Completely submerge the thermostat in water.
3. Heat the water.
4. Stir the water constantly to avoid direct heat being applied to the thermostat.
5. Refer to Specifications:
   a. Check the thermostat initial opening temperature.
   b. Check the thermostat full opening temperature.
   c. Check valve lift at fully open position.



Typical thermostat

a - Thermometer
b - Agitating rod
c - Wooden blocks
d - Thermostat

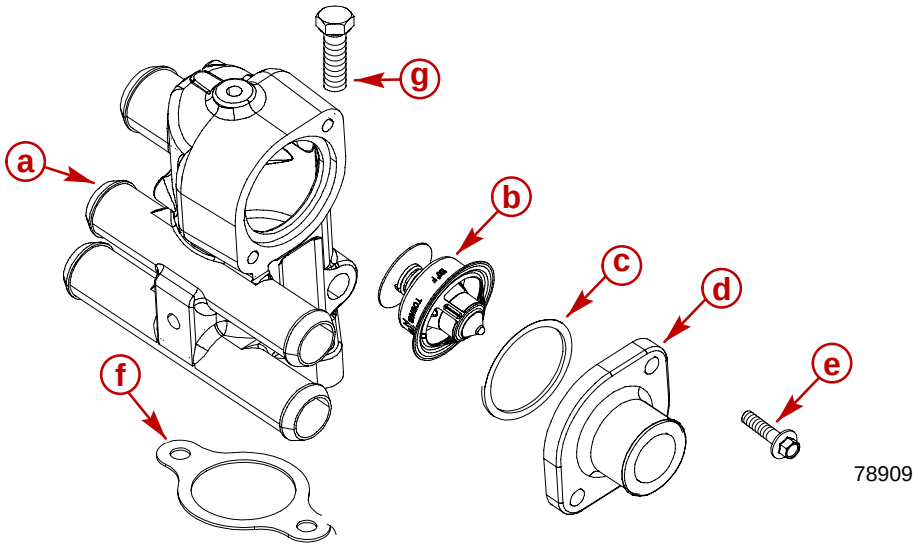
6. Replace if specifications are not met or damage is discovered during inspection.

Installation

1. Remove the thermostat housing and the gaskets. Discard the gaskets.
2. Clean the gasket surfaces on the thermostat cover, the thermostat housing, and the intake manifold.
3. Position the gasket on the intake manifold. Place the thermostat housing on the gasket.
4. Torque the screws.

Description	Nm	lb-in.	lb-ft
Thermostat housing to intake screw	33		24

5. Install the rubber seal on the thermostat flange.
6. Install the thermostat into the thermostat housing.
7. Install the thermostat cover. Torque the screws.



a - Thermostat housing
b - Thermostat
c - Thermostat housing seal
d - Thermostat housing cover
e - Thermostat housing cover screw (2)
f - Gasket
g - Thermostat housing to intake screw (2)

MCM MODEL 0M599999 AND BELOW / MIE MODEL 0M316999 AND BELOW

Description	Nm	lb-in.	lb-ft
Thermostat cover screw	41		30

MCM MODELS 0M600000 AND ABOVE / MIE MODELS 0M317000 AND ABOVE

Description	Nm	lb-in.	lb-ft
Thermostat cover screw	30		22

8. Connect the hoses. Tighten the hose clamps securely.
9. Supply cooling water, start the engine, and inspect for leaks.

Changing Coolant

Closed Cooling Section

The engine and exhaust sections of closed cooling system should remain filled year-round with the recommended coolant solution. Do not drain closed cooling section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, ensure that closed cooling section is filled with Extended Life Coolant or an ethylene glycol antifreeze and water solution, mixed to manufacturer's recommended proportions, to protect engine to lowest temperature to which it will be exposed. If necessary, change coolant using coolant specified in "Coolant Recommendations."

Change Intervals

If the closed cooling system is factory installed, drain and flush coolant from the closed cooling system at least every five years or 1000 hours of operation, whichever comes first. It should also be changed whenever exhaust gases have entered the system.

If the system is not factory installed or has had anti-freeze other than Extended Life Coolant added, it must be changed every two years or 400 hours of operation, whichever comes first.

Draining

⚠ WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On some models with two piece petcock, removal of petcock may be required so that wire can be inserted completely into drain hole.

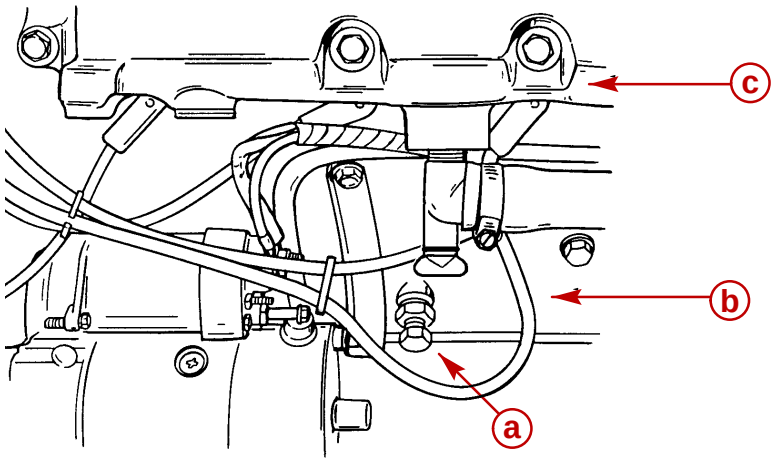
IMPORTANT: Engine must be as level as possible to ensure complete draining of cooling system.

IMPORTANT: Closed cooling section must be kept filled year round with recommended coolant. If engine will be exposed to freezing temperatures, ensure that closed cooling section is filled with Extended Life Coolant or an ethylene glycol antifreeze and water solution properly mixed to protect engine to lowest temperature to which it will be exposed.

The following draining instructions apply to all engines equipped with closed cooling. The location of petcocks that require opening and hoses that require removal are represented on the following pages for the individual engines.

MCM MODELS 0M599999 AND BELOW / MIE MODELS 0M316999 AND BELOW

1. Remove pressure cap from coolant tank.
2. On port and starboard side of engine block, remove the block plugs. Drain coolant into proper container.

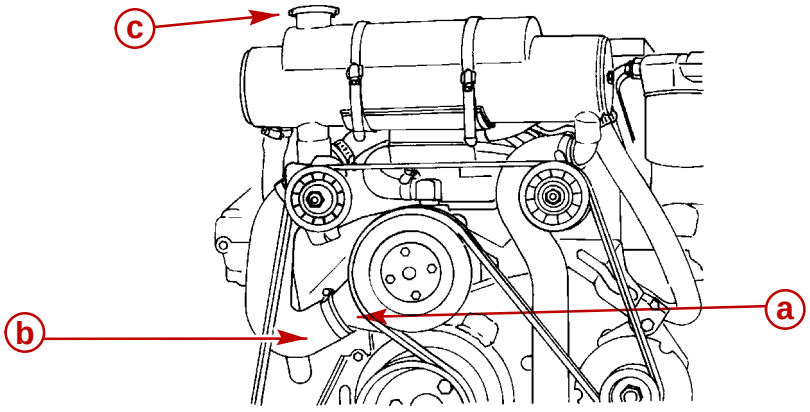


74073

Port and starboard side similar

a - Engine block drain plug
b - Engine block
c - Exhaust manifold

3. Remove the heat exchanger to water circulating pump hose at the pump connection. Drain coolant into proper container.



75209

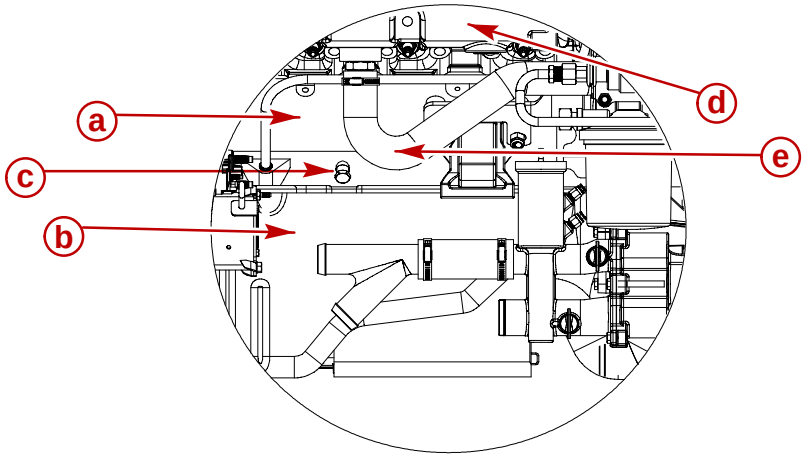
Typical engine shown

a - Water circulating pump
b - Hose from heat exchanger to water circulating pump
c - Pressure cap from coolant tank

4. After coolant has drained completely, reinstall block plug and hoses. Tighten clamps securely.
5. Remove coolant recovery bottle from mounting bracket and discard the coolant into a proper container.

MCM MODEL 0M600000 AND ABOVE / MIE MODEL 0M317000 AND ABOVE

1. Remove pressure cap from coolant tank.
2. On port and starboard side of engine block, remove the block pipe plugs. Drain coolant into proper container.
3. On port and starboard side of engine block, remove the coolant hose from the bottom side of the exhaust manifold. Drain coolant into proper container.

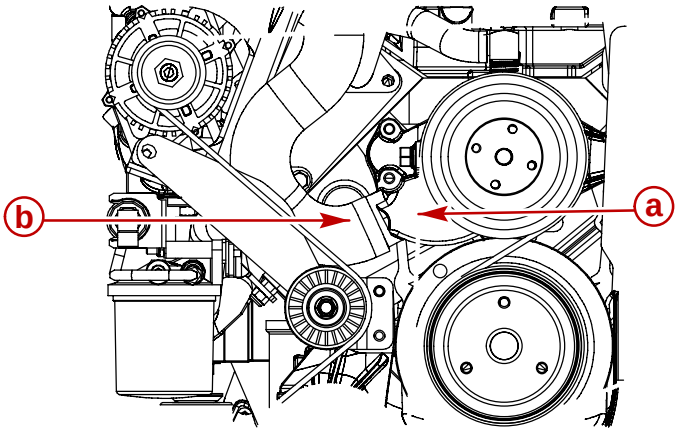


78905

Port and starboard side similar

a - Engine block
b - Oil pan
c - Engine block drain plug
d - Exhaust manifold
e - Exhaust manifold coolant hose

4. Remove the heat exchanger to water circulating pump hose at the pump connection. Drain coolant into proper container.



78648

a - Water circulating pump
b - Hose from heat exchanger to water circulating pump

5. After coolant has drained completely, reinstall block pipe plug and hoses. Tighten clamps securely.
6. Remove coolant recovery bottle from mounting bracket and discard the coolant into a proper container.

Cleaning System

Closed Cooling Section

Closed cooling section of closed cooling system should be cleaned at least once every five years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale, or other foreign material. Always follow manufacturer's instructions for the cleaner.

If closed cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow to allow water to get behind deposits and force them out. Refer to instructions that accompany flushing device for proper hookup and flushing procedure.

NOTICE
For information and procedures on draining and flushing Seawater Section of Closed Cooling (Coolant) Models, and for cold weather or extended storage, refer to the appropriate Mercury MerCruiser Service Manual.

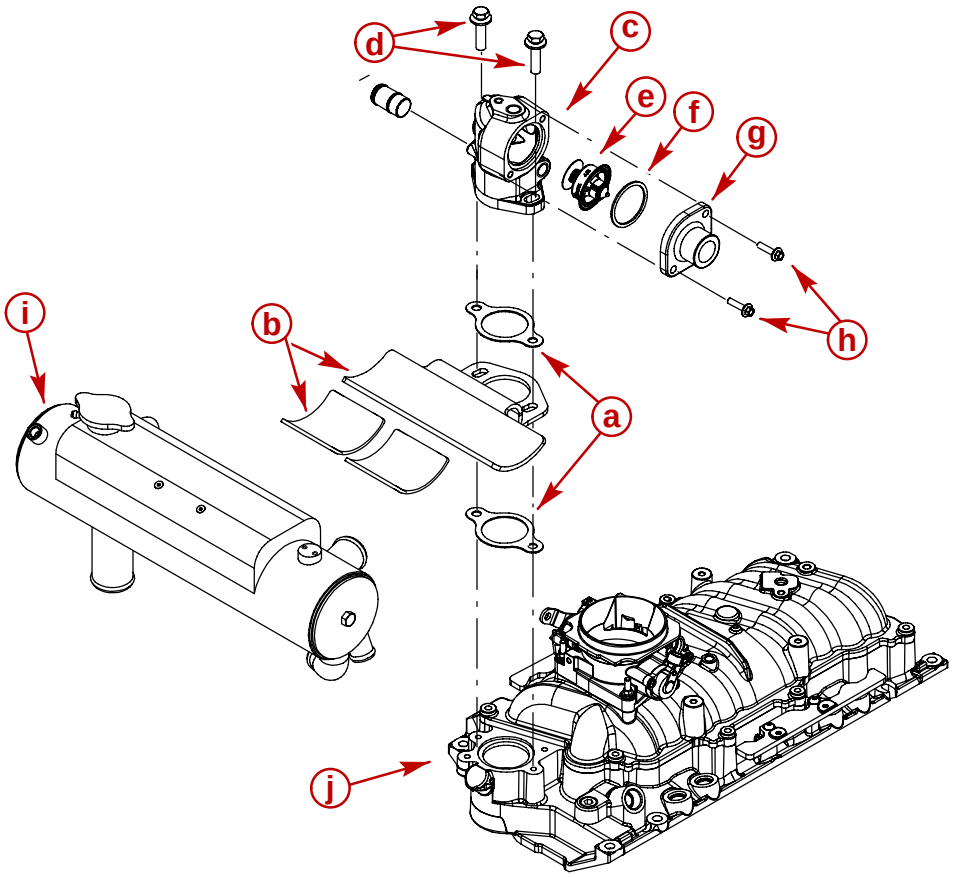
Seawater Section

Cooling efficiency of an engine with closed cooling is greatly dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, lime, etc.) collect on the inside of the tubes, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. It is, therefore, recommended that the seawater section of the heat exchanger be cleaned as specified in **Section 1B** or whenever decreased cooling efficiency is suspected.

Heat Exchanger Assembly

Exploded View

MCM MODEL 0M599999 AND BELOW / MIE MODEL 0M316999 AND BELOW

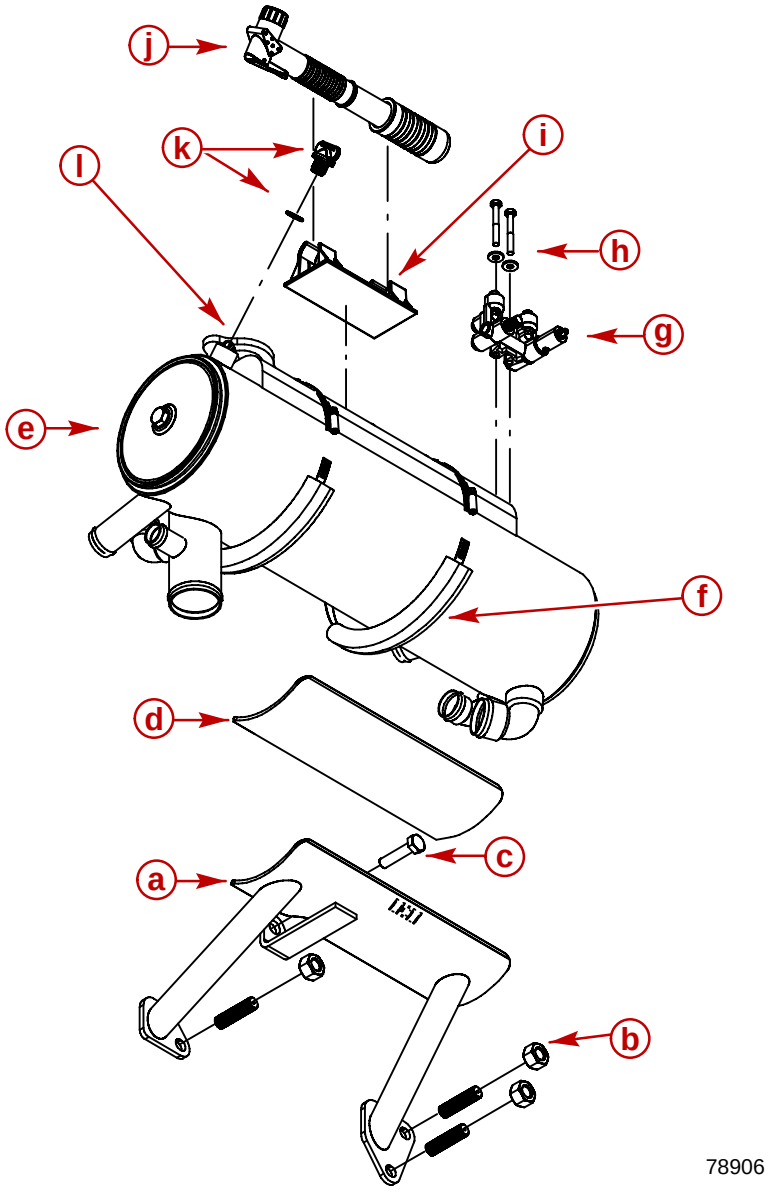


78148

Typical engine shown

- **a** - Gasket
- **b** - Heat exchanger bracket and pads
- **c** - Thermostat housing
- **d** - Screws
- **e** - Thermostat
- **f** - Quad-ring seal
- **g** - Thermostat cover
- **h** - Screws
- **i** - Heat exchanger
- **j** - Intake manifold

MCM 0M600000 AND ABOVE / MIE 0M317000 AND ABOVE



a - Heat exchanger bracket
b - Heat exchanger bracket locknuts (3)
c - Heat exchanger bracket bolt
d - Heat exchanger bracket pad
e - Heat exchanger
f - Heat exchanger to heat exchanger bracket clamp assembly (2)
g - Air manifold
h - Air manifold screws and washers (2)
i - Air pump bracket (later style)
j - Air pump
k - Air vent plug and O-ring
l - Heat exchanger cap

Testing

INTERNAL LEAKS

An internal leak will allow coolant to enter into the seawater circuit when the closed cooling circuit is pressurized.

1. Remove a seawater hose from the exchanger. Do not drain the exchanger.
2. Pressurize the closed cooling circuit to 110-138 kPa (16-20 psi) with a radiator tester.
3. If seawater begins to flow from the seawater hose fitting of the heat exchanger, there is a leak.

BLOCKAGE

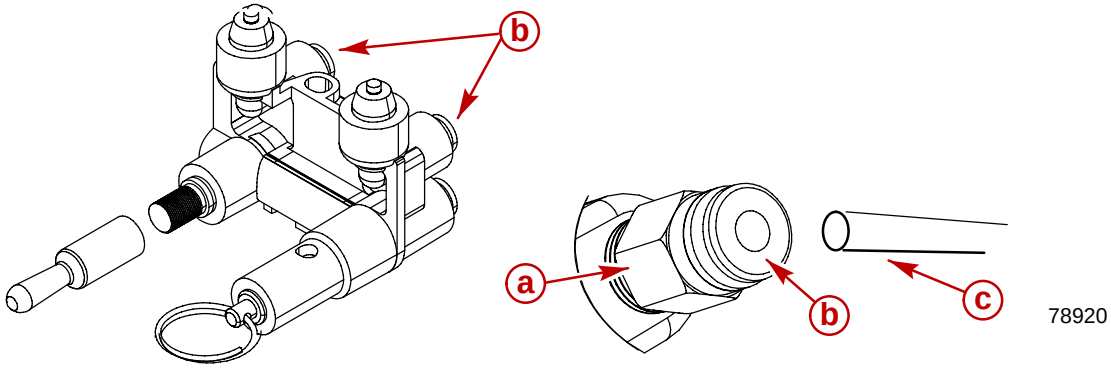
IMPORTANT: Seawater flows THROUGH the tubes in the exchanger. Closed cooling coolant flows AROUND the tubes.

1. Remove the end caps and inspect for any blockage in the seawater circuit (broken impeller blades, weeds, etc.).
2. Remove the closed cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

Removal

NOTE: *The heat exchanger does not have to be removed for cleaning.*

1. Allow engine to cool.
2. Drain the seawater from the engine.
3. Drain the coolant from the engine.
4. If applicable, remove each air line from the air manifold by pressing on the fitting and pulling the line out.



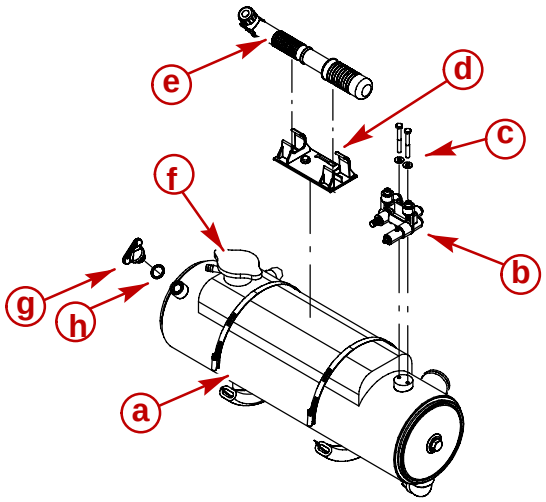
a - Air line fitting
b - Release location
c - Air line

5. Remove the hoses from the heat exchanger.
6. Remove the 2 large hose clamps fastening the heat exchanger to the engine.
7. Remove the heat exchanger.

Disassembly

IMPORTANT: Do not remove the air pump and air pump bracket if mounted to engine compartment.

1. Remove the air pump from the air pump bracket.
2. If air pump bracket is secured with adhesive, do not remove.

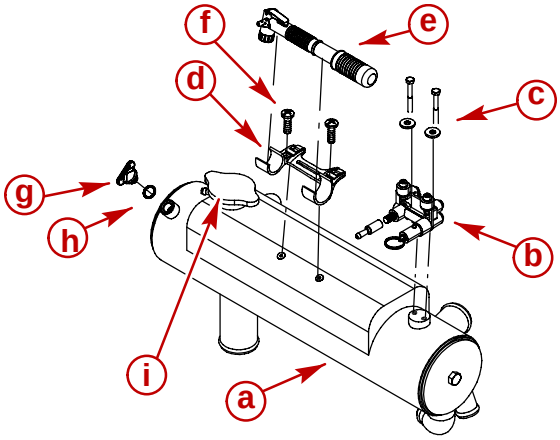


78906

Mounted on top of heat exchanger and secured with adhesive

- **a** - Heat exchanger
- **b** - Air manifold
- **c** - Air manifold screws and washers
- **d** - Air pump bracket (later style)
- **e** - Air pump
- **f** - Heat exchanger cap
- **g** - Air vent plug
- **h** - O-ring

3. If air pump bracket is secured by screws, remove the air pump bracket.



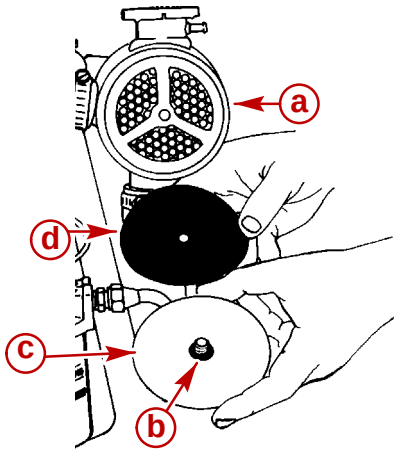
78148

Mounted on front edge of heat exchanger and secured with screws

- **a** - Heat exchanger
- **b** - Air manifold
- **c** - Air manifold screws
- **d** - Air pump bracket (early style)
- **e** - Air pump
- **f** - Air pump bracket screws
- **g** - Air vent plug
- **h** - O-ring
- **i** - Heat exchanger cap

4. Remove the air manifold.

5. Remove the screws attaching the end cap to the heat exchanger.
6. Remove the end caps and gaskets.



71515

a - Heat exchanger
b - Sealing washer
c - End cap
d - Gasket

Cleaning And Inspection

1. Clean old gasket material and sealant from surfaces. Do not nick or gouge the surfaces.
2. Use a long rod and wire brush to clean out heat exchanger tubes.
3. Inspect each part for cracks or other damage. Replace as necessary.
4. Clean and paint exterior surfaces as required to prevent corrosion.

Repair

IMPORTANT: Braze with BCUP 2 rod or silver solder. Care must be taken not to melt the other joints during repair.

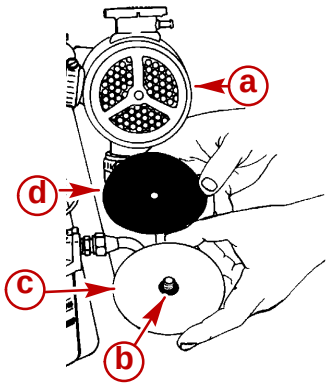
1. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in the cooling capacity. Do not close more than three tubes.
2. Fittings and drains that have been broken off the heat exchanger can be reattached by brazing.

Assembly

1. Apply sealant to both sides of new end cap gaskets.

Description	Where Used	Part Number
Perfect Seal	Heat exchanger end cap gaskets	92-34227-1

2. Install new gaskets, new sealing washers, and end caps onto heat exchanger. Torque the end cap screws.



71515

a - Heat exchanger
b - Sealing washer
c - End cap
d - Gasket

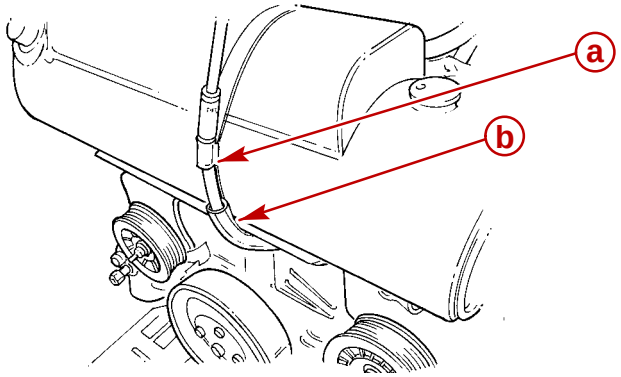
Description	Nm	lb-in.	lb-ft
Heat exchanger end cap screw	6	54	

3. If applicable, fasten the air pump bracket to the heat exchanger. Tighten the screws securely.
4. Fasten the air manifold to the heat exchanger.
5. Torque screws.

Description	Nm	lb-in.	lb-ft
Air manifold to heat exchanger screw	3	27	

Installation

1. Lower heat exchanger onto bracket and simultaneously attach water hoses.
2. Ensure that all hose ends are aligned and fully seated on heat exchanger fittings. Tighten all hose clamps securely.
3. Install large hose clamps around heat exchanger bracket and heat exchanger.
4. Install the hose clamps around the heat exchanger. The rubber hose should be underneath the bracket to prevent the bracket from directly contacting the hose clamp and potentially breaking it.



78405

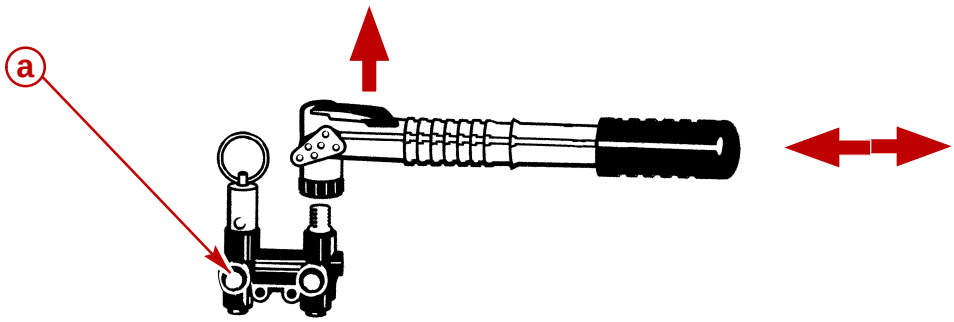
Later model shown, early model similar

a - Hose clamp
b - Rubber hose

5. Torque hose clamps.

Description	Nm	lb-in.	lb-ft
Hose clamps around heat exchanger and bracket	3	26	

6. Install the air lines to the air manifold by inserting the line into the fitting until a positive stop is encountered.
7. Ensure that the air lines are installed properly.
   a. Install air pump on the fitting in the air manifold.



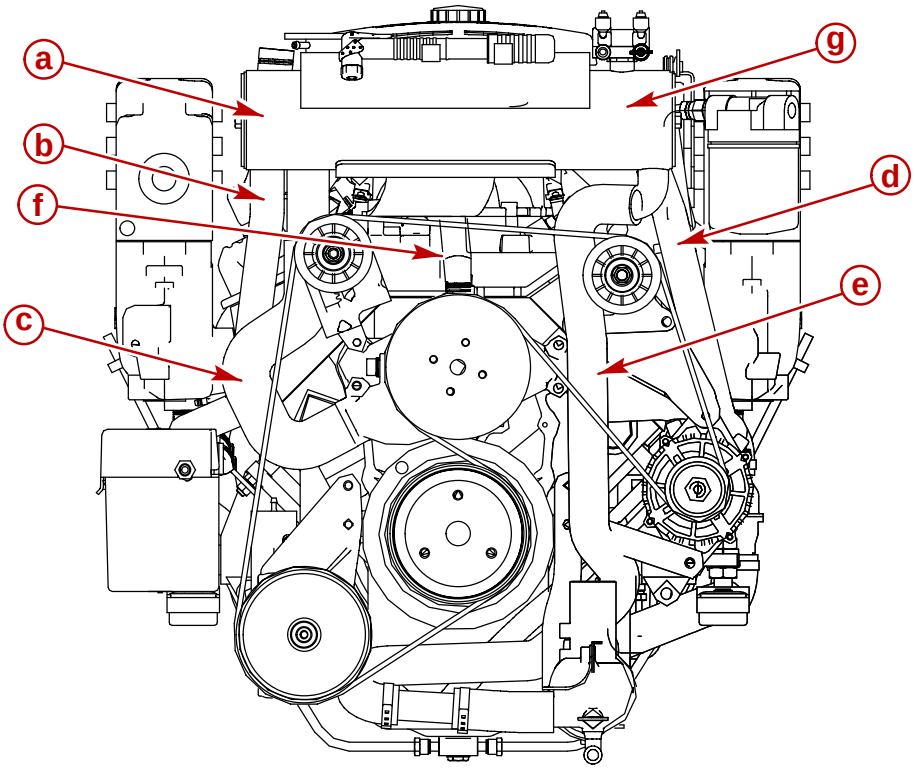
77638

a - Green indicators

   b. Pull lever on air pump up (vertical) to lock pump on the fitting.
   c. Pump air into the system until both green indicators extend. If the green indicators do not extend, the air lines are not attached properly.
8. Fill closed cooled system.

Heat Exchanger Hose Connections

MCM 0M300000 Through 0M599999 / MIE 0M310000 Through 0M316999

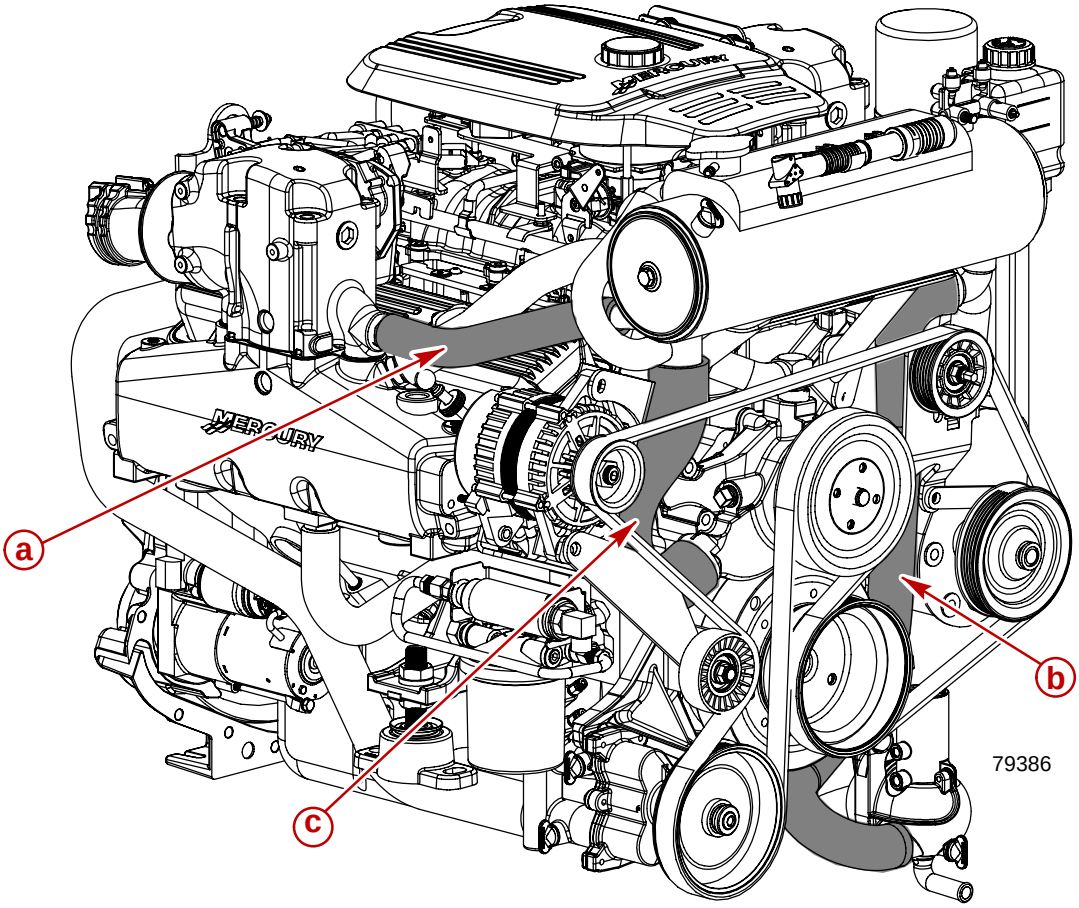


77954

Typical engine shown

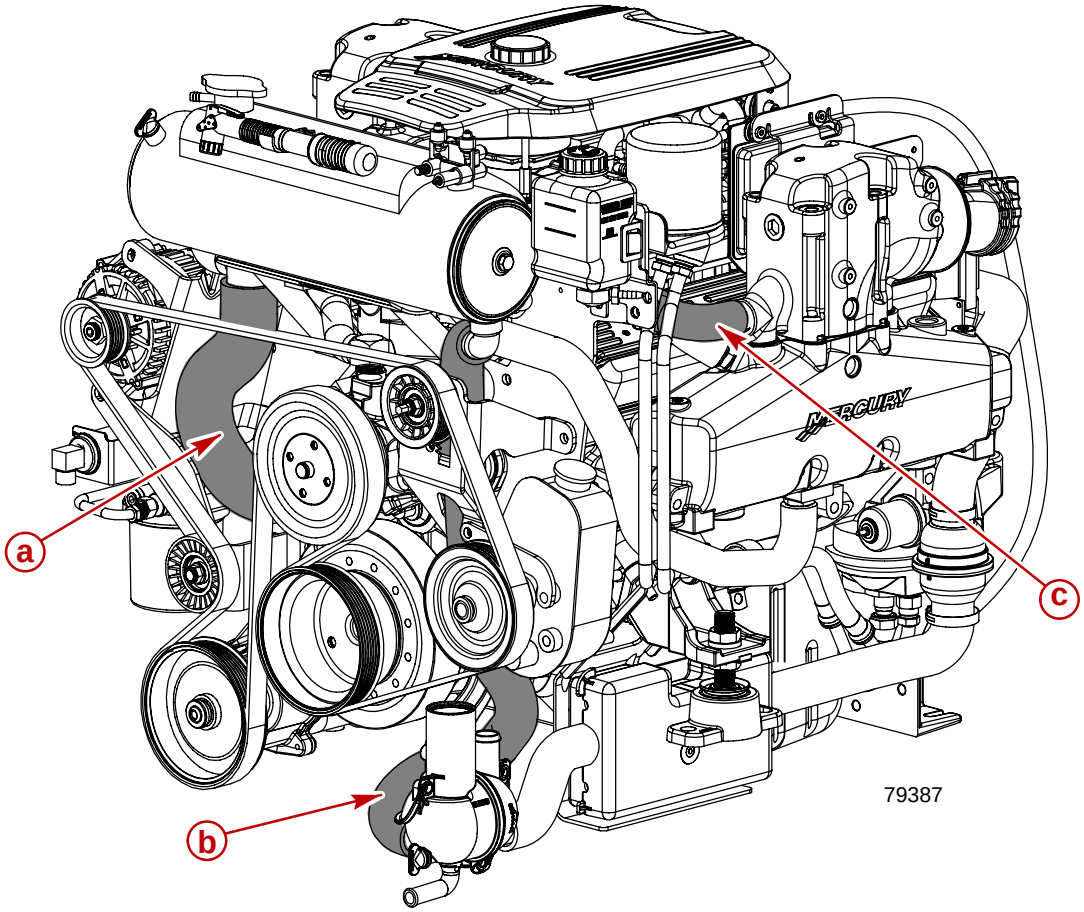
- **a** - Heat exchanger
- **b** - Starboard heat exchanger to exhaust manifold hose
- **c** - Water circulating pump hose
- **d** - Port heat exchanger to exhaust manifold hose (MCM)
- **e** - Cool fuel system to heat exchanger hose
- **f** - Heat exchanger bypass hose
- **g** - Coolant identification decal

MCM Model 0M600000 And Above / MIE Model 0M317000 And Above



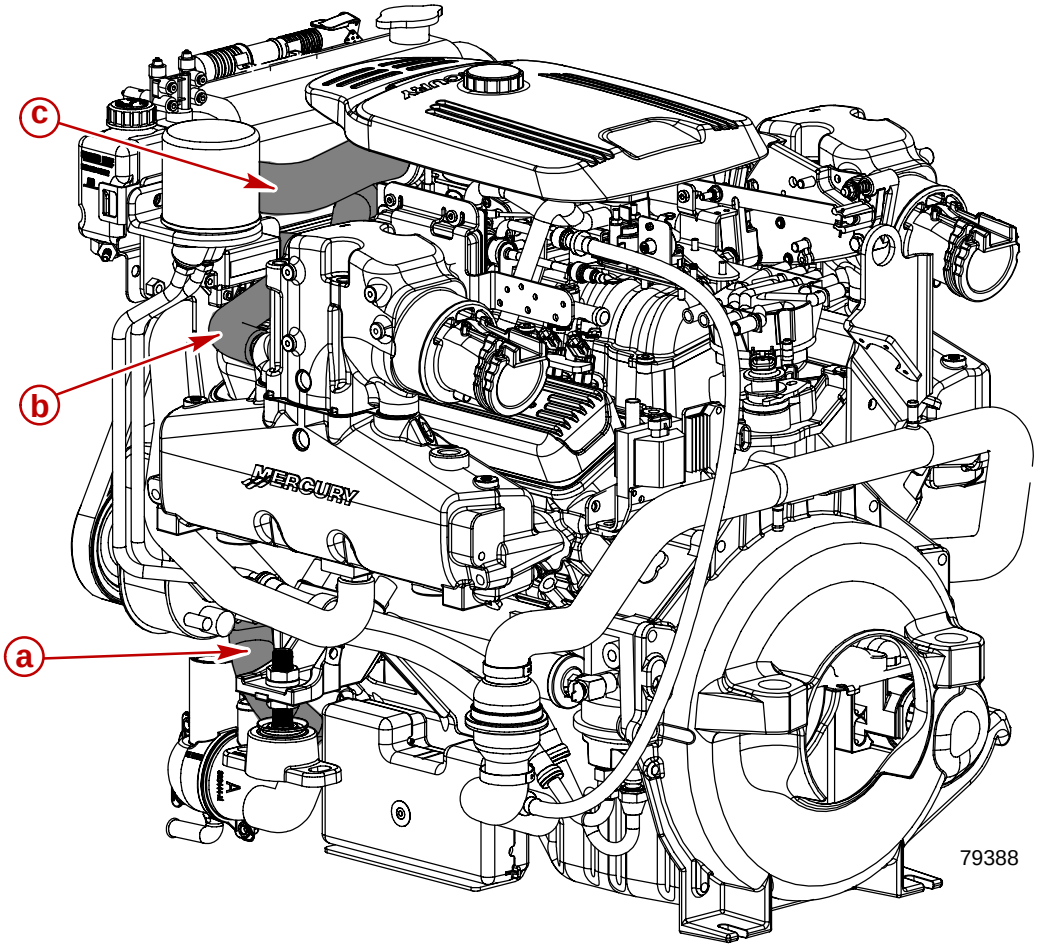
a - Heat exchanger to starboard exhaust elbow
b - Heat exchanger to water distribution housing
c - Heat exchanger to water pump

MCM Model 0M600000 And Above / MIE Model 0M317000 And Above (Continued)



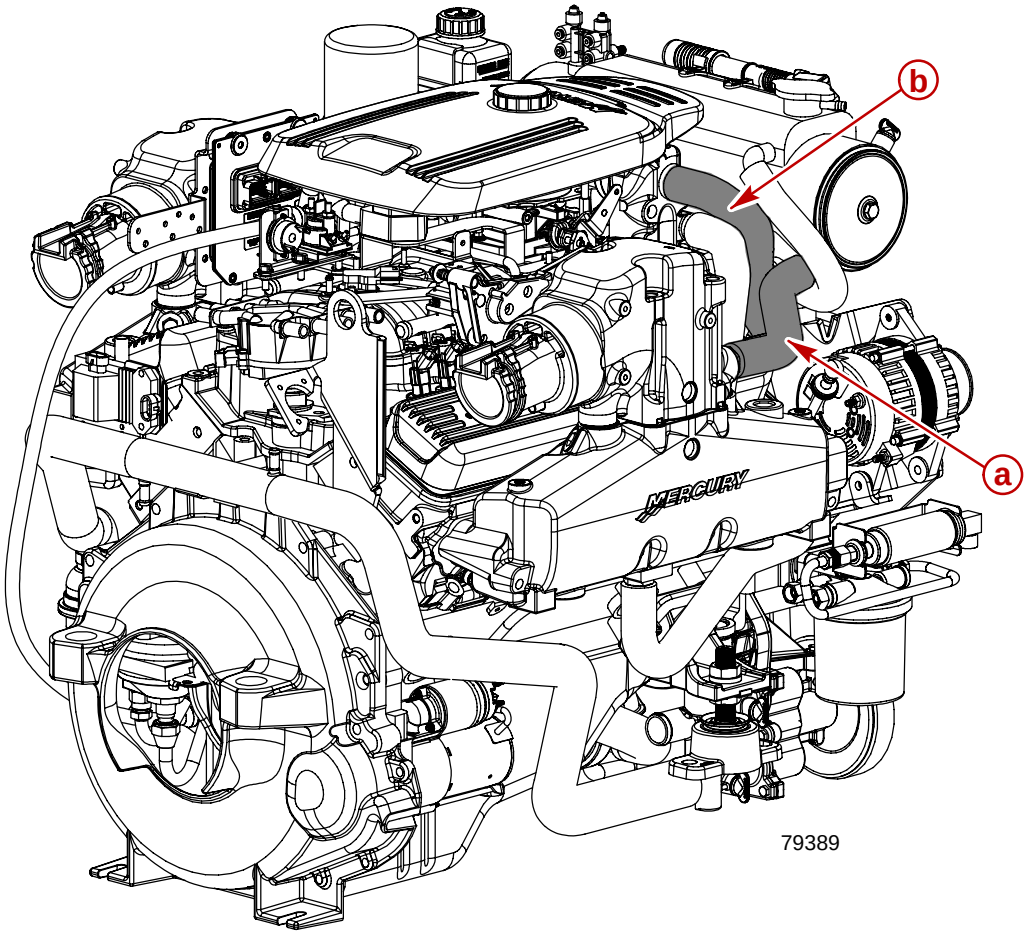
a - Heat exchanger to water pump
b - Heat exchanger to water distribution housing
c - Heat exchanger to port exhaust elbow

MCM Model 0M600000 And Above / MIE Model 0M317000 And Above (Continued)



a - Heat exchanger to water distribution housing
b - Heat exchanger to port exhaust elbow
c - Heat exchanger to thermostat housing

MCM Model 0M600000 And Above / MIE Model 0M317000 And Above (Continued)



a - Heat exchanger to starboard exhaust elbow
b - Heat exchanger to thermostat housing

NOTES:

EXHAUST SYSTEMS

Section 7A - Manifolds, Elbows, And Risers For Wet Joint

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7 A

Models Covered

Wet Joint Models

Wet Joint Models	Serial Number
Sterndrive (MCM) models	0M300000 Through OM599999
Inboard and Tow Sports (MIE) models	0M310000 Through OM316999

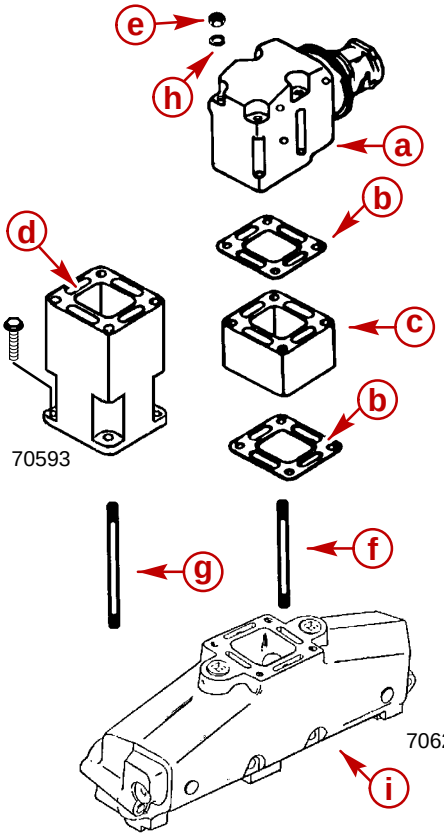
Lubricants / Sealants / Adhesives

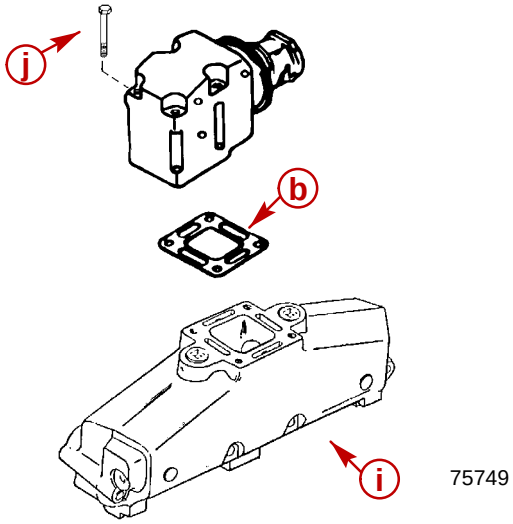
Description	Where Used	Part Number
Perfect Seal	Exhaust manifold and elbow plugs	92-34227-1
	Gasket surface exhaust manifold to elbow and to riser	
Loctite 567 PST Pipe Sealant	Exhaust manifold and elbow plugs	92-809822

Equivalent products may be used.

Exploded View

Carbureted Models

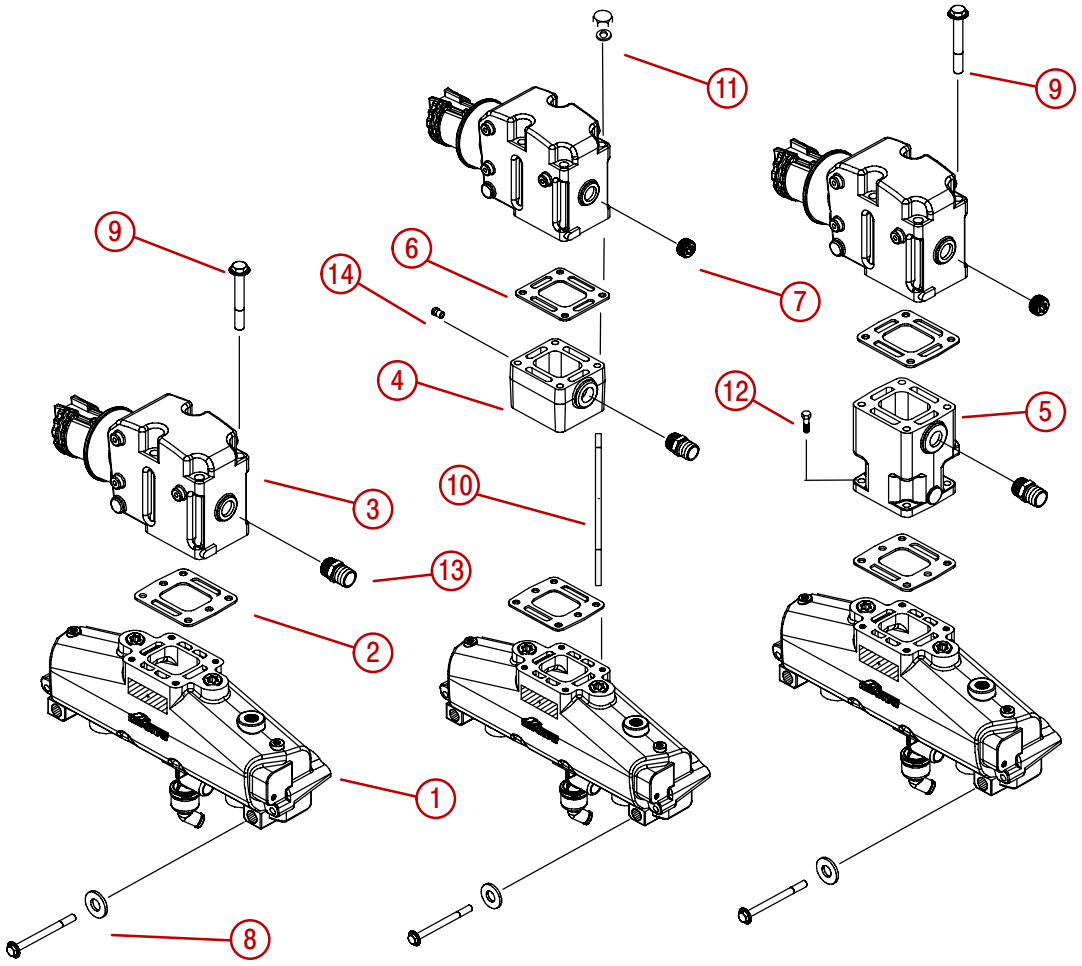




Elbows with risers **Elbows without risers**

- **a** - Exhaust elbow
- **b** - 4 Slot gasket
- **c** - 76 mm (3 in.) exhaust riser
- **d** - 152 mm (6 in.) exhaust riser
- **e** - Nut (8)
- **f** - Stud
- **g** - Stud (used with some MIE remote oil filters)
- **h** - Washer (8)
- **i** - Exhaust manifold
- **j** - Bolts

MPI Models



No riser **76 mm (3 in.) riser** **152 mm (6 in.) riser**

1 - Exhaust manifold
2 - Restrictor gasket
3 - Exhaust elbow
4 - 76 mm (3 in.) riser
5 - 152 mm (6 in.) riser
6 - Open gasket
7 - Plug
8 - Manifold to cylinder head bolt and washer
9 - Exhaust elbow to exhaust manifold bolt
10 - Stud
11 - Exhaust elbow to 76 mm (3 in.) riser nut and washer
12 - 152 mm (6 in.) riser to exhaust manifold bolt
13 - Hose fitting
14 - Pipe plug

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

Description		Nm	lb-in.	lb-ft
Exhaust elbow or riser to exhaust manifold bolt or nut				
Tighten fasteners evenly using X pattern from corner to corner	First pass	27.1		20
	Final pass	44.7		33
Exhaust manifold to cylinder head bolt		33.8		25

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables from the battery.

⚠ CAUTION

To avoid severe engine damage, exhaust elbows and manifolds MUST BE drained to prevent water from entering the combustion chambers when the exhaust elbows are removed.

2. Drain the seawater section of the engine. Refer to **Section 1B**.
3. Disconnect the exhaust hoses and the cooling hoses from the exhaust manifold and elbow.
4. **MCM Only:** Remove the shift plate.
5. Remove the ECM and the ECM bracket.
6. Remove any other components that are mounted to the manifold, the elbow, and the riser.
7. Remove the elbow and the riser.
8. Remove the exhaust manifold and discard the gaskets.

Cleaning And Inspection

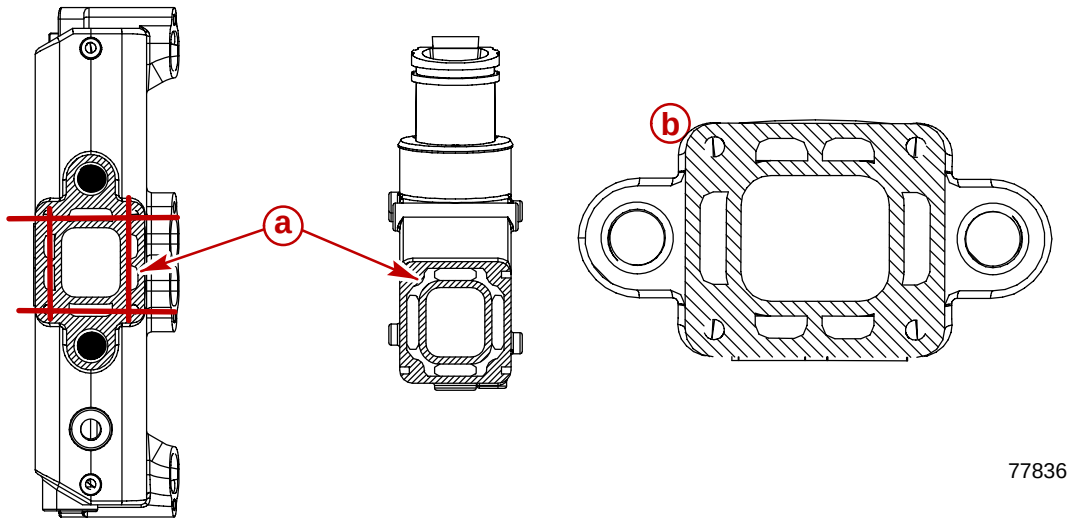
1. Clean the gasket material from all surfaces and wash the parts in solvent.
2. Inspect the water passages for foreign material. The passages must be clean for efficient cooling.

NOTE: *If more thorough inspection is desired, the pipe plugs may be removed from the exhaust manifold and the exhaust elbow.*

IMPORTANT: If the pipe plugs are removed, coat the threads with sealant before reinstalling.

Description	Where Used	Part Number
Loctite 567 Pipe Sealant	Exhaust manifold and elbow plugs	92-809822

3. Inspect for cracks.
4. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches or water and exhaust leaks may result.
5. Inspect for damaged metal caused by saltwater or exhaust gas corrosion in the manifold, elbow, and riser.
6. Measure the surface flatness of all gasket surfaces on the manifold, elbow, and riser.



a - Gasket surfaces
b - Exhaust manifold surface shown

Description		mm (in.)
Surface flatness	Maximum overall difference	0.07 (0.003)

NOTE: *The maximum material that can be removed is 0.25 mm (0.010 in.). When torquing the attaching bolts, ensure that they are not contacting the bottom of the threaded hole in the manifold.*

NOTE: *Gasket is not reusable. Inspect for proper gasket replacement before disassembly and assembly.*

7. Replace all damaged components.

Manifold Leak Test

NOTE: *One block-off plate must have an attachment for a compressed air hose.*

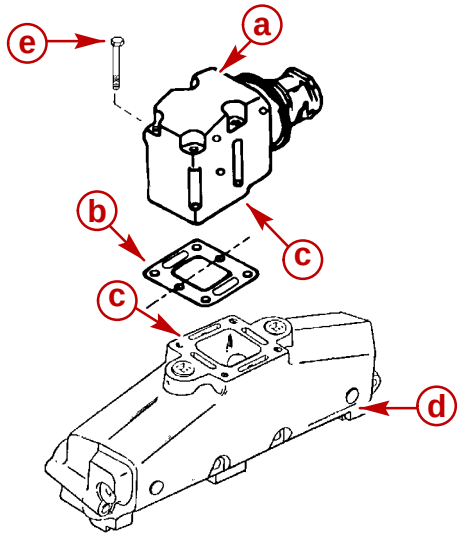
1. Using suitable block-off plates, plugs, and new gaskets, seal the manifold openings.
2. Attach an air hose to the block-off plate.
3. Apply 276 kPa (40 psi) of air pressure and submerge the manifold in water.
4. Air bubbles will indicate a leak. Repair or replace, if necessary.

Installation

1. Using a new gasket, install the exhaust manifold.

Description	Nm	lb-in.	lb-ft
Exhaust manifold to cylinder head bolt	33.8		25

2. Using a new gasket, apply sealant to gasket surface
3. **For 76 mm (3 in.) Risers**, install studs into the manifold.
4. Install the exhaust riser and exhaust elbow to the exhaust manifold.



75749

a - Exhaust elbow
b - Gasket
c - Gasket surface
d - Exhaust manifold
e - Bolts

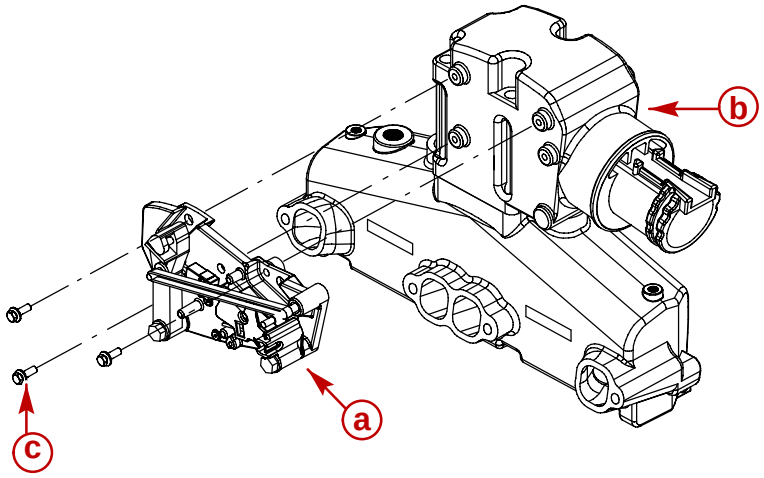
Description	Where Used	Part Number
Perfect Seal	Gasket surface exhaust manifold to elbow and to riser	92-34227-1

5. If applicable, install remote oil assembly with exhaust elbow bolts.

6. Torque the bolts or nuts.

Description		Nm	lb-in.	lb-ft
Exhaust elbow or riser to exhaust manifold bolt or nut				
Tighten fasteners evenly using X pattern from corner to corner	First pass	27.1		20
	Final pass	44.7		33

7. **Starboard exhaust elbow MCM models:**
   a. Install the drop-down shift plate bracket, if equipped.
   b. Install the shift plate assembly to the elbow.
   c. Connect both shift cables.
   d. Tighten securely.
   e. Connect instrument harness plug to engine harness and install bolt to secure water separating fuel filter bracket to exhaust manifold, if disconnected previously.

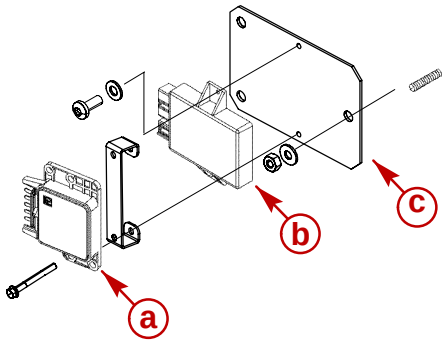


77825

Starboard exhaust elbow MCM models

a - Shift plate
b - Exhaust elbow
c - Bolts

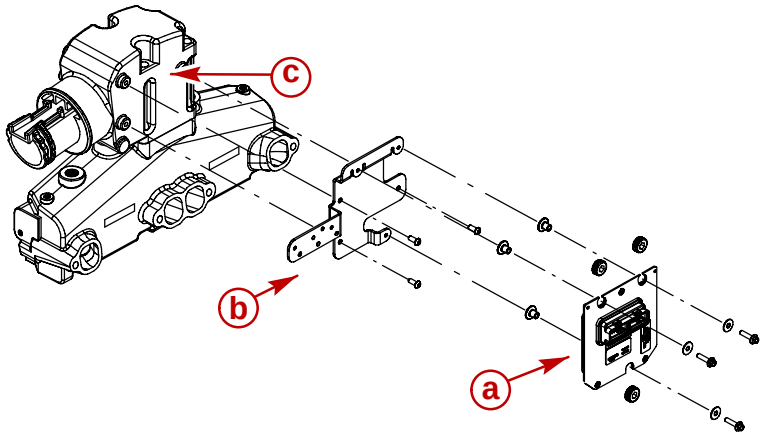
8. **Port Exhaust Elbow:**
   a. Install the ECM drop-down bracket, if equipped.
   b. Install the ECM bracket and the ECM to the exhaust elbow.
   c. Tighten securely.



79370

Carbureted models

a - Knock module
b - Ignition module
c - Drop-down bracket



77825

MPI models

a - ECM
b - ECM bracket
c - Exhaust elbow

9. Install the exhaust hoses and the cooling hoses.
10. Tighten hose clamps securely.
11. Install any additional components removed during disassembly.
12. Reconnect the battery cables to the battery. Tighten securely.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

13. Supply cooling water to the engine.
14. Start the engine and check for exhaust and water leaks.

NOTES:

EXHAUST SYSTEMS

Section 7B - Dry Joint Identification

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7
B

Models Covered

Warm Manifold And Cold Riser Models

Model	Serial Number
Sterndrive (MCM) models	0M600000 - 0M614999
Inboard and Tow Sports (MIE) models	0M317000 - 0M389999

Warm Manifold And Warm Riser Models

Model	Serial Number
Sterndrive (MCM) models	0M615000 and Above
Inboard and Tow Sports (MIE) models	0M390000 and Above

Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Perfect Seal	Water ports	92-34227-1

General Information

Closed Cooled Models

1/2 LOOP

Engine models in service manuals number 24, 25, and 32 are 1/2 closed cooling systems or 1/2 systems. The term 1/2 closed cooling system refers to the use of ethylene glycol mixture in the engine cooling passages and the use of seawater in the exhaust water jackets.

FULL LOOP

Engine models covered in this section are considered a full closed cooling system. The term full closed cooling system, also known as full fresh water cooled or full FWC, refers to the use of ethylene glycol mixture in the engine and the exhaust water jackets.

Seawater Cooled Models

The term seawater cooled, also known as raw water cooled or RWC, refers to the use of water, such as seawater, for cooling throughout the system, in the engine cooling passages, and in the exhaust water jackets. This water source is picked up through the sterndrive and engine seawater pump.

Cold Manifolds

Cold manifolds contain fluid that enters the exhaust manifold near seawater temperature.

Warm Manifolds

Warm manifolds contain fluid that enters the exhaust manifold near thermostat operating temperature. The temperature is warm enough to evaporate moisture that collects on interior exhaust passages due to condensation. All dry joint models are warm manifold engines.

Wet Joint

Wet joint is a description based on the style of exhaust system on these engines. The wet joint exhaust system confines both the engine seawater and exhaust gases with the same gasket sealing surface at the exhaust manifold to elbow joint (wet joint). In the exhaust elbow, the engine seawater and exhaust gases are mixed and discharged together. This system was used on engines produced prior to 2002. These engines are equipped with cold manifolds.

Dry Joint

Dry joint is a description based on the style of exhaust system on these engines. In a dry joint exhaust system the engine seawater and the exhaust gas are separated by different gasket sealing surfaces at the exhaust manifold to elbow joint (dry joint). In the exhaust elbow, the engine seawater and exhaust gases are mixed and discharged together.

Cold Riser

Fluid from the exhaust manifold is prevented from entering a cold riser by the gasket.

Warm Riser

Fluid enters the warm riser from the exhaust manifold due to the style of the turbulator gasket.

Turbulator Gasket

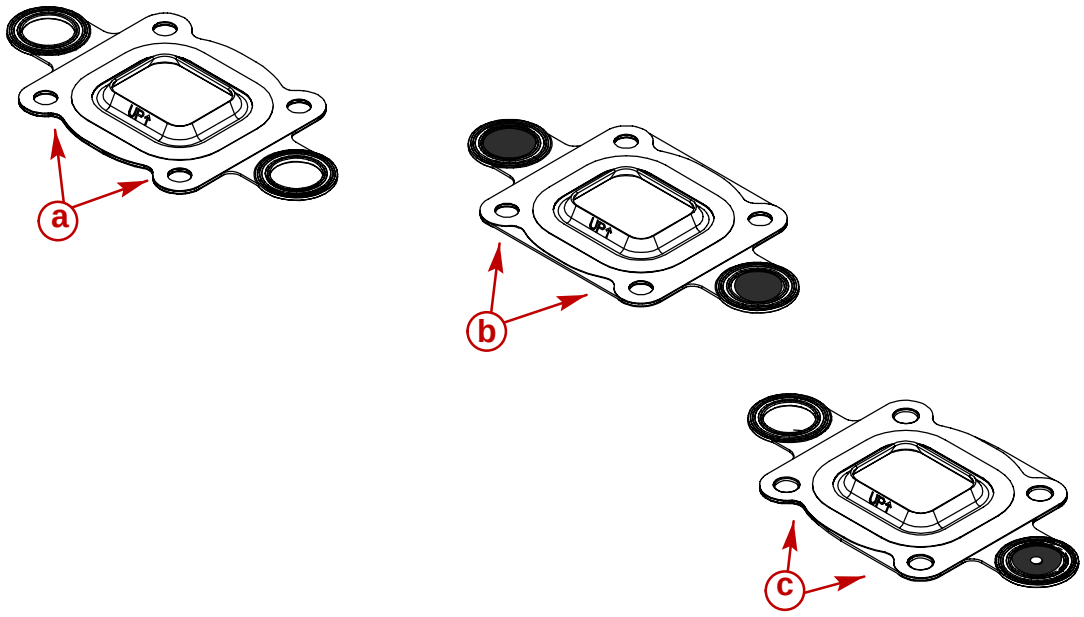
Identification

⚠ CAUTION

Avoid severe engine damage. The turbulator gasket used MUST BE the Mercury turbulator gasket specified for your engine package. Engine damage that results from improper gasket use is considered misuse of the engine and is not covered under Mercury MerCruiser Warranty.

IMPORTANT: Gasket identification can be viewed externally on the engine package. The outer edge of each turbulator gasket identifies the gasket and the gasket position.

- The full flow gasket is contoured at the edge to show full flow at each water port.
- The block-off gasket is straight at the edge to show no flow at each port.
- The restrictor gasket is contoured at one edge of gasket to show full flow. The other edge of gasket is straight to show restricted flow.



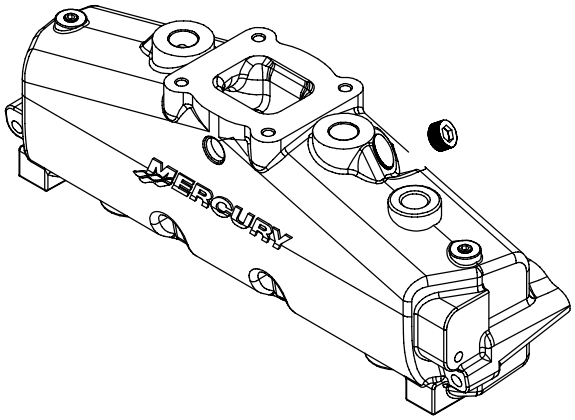
78805

a - Full flow gasket
b - Block off gasket
c - Restrictor gasket

NOTE: *Gasket is not reusable. Inspect for proper gasket replacement before disassembly and assembly.*

Exhaust Manifold

The warm exhaust manifold is a new casting design and cannot be replaced with the cold exhaust manifold casting. This warm exhaust manifold casting is used in cold riser and warm riser applications.



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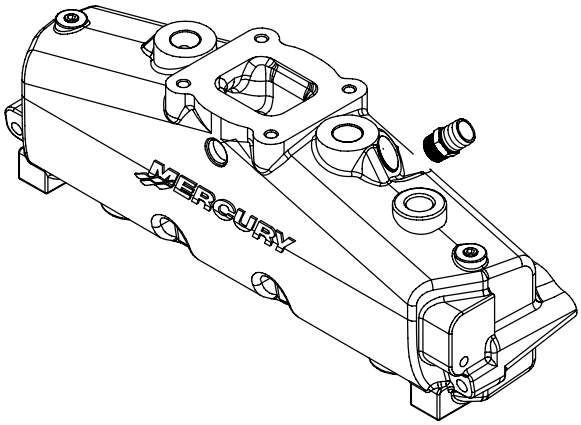
Exhaust manifold outlet water port with pipe plug



78900

Exhaust manifold outlet water port with hose fitting

NOTE: *Using Perfect Seal on water ports is a preventive measure for corrosion deterioration.*

Description	Where Used	Part Number
Perfect Seal	Water ports	92-34227-1

Manifold Leak Test

NOTE: *One block-off plate must have an attachment for a compressed air hose.*

1. Using suitable block-off plates, plugs, and new gaskets, seal the manifold openings.
2. Attach an air hose to the block-off plate.
3. Apply 138 kPa (20 psi) of air pressure and submerge the manifold in water.
4. Air bubbles will indicate a leak. Repair or replace, if necessary.

Exhaust Riser

Cold Riser Casting

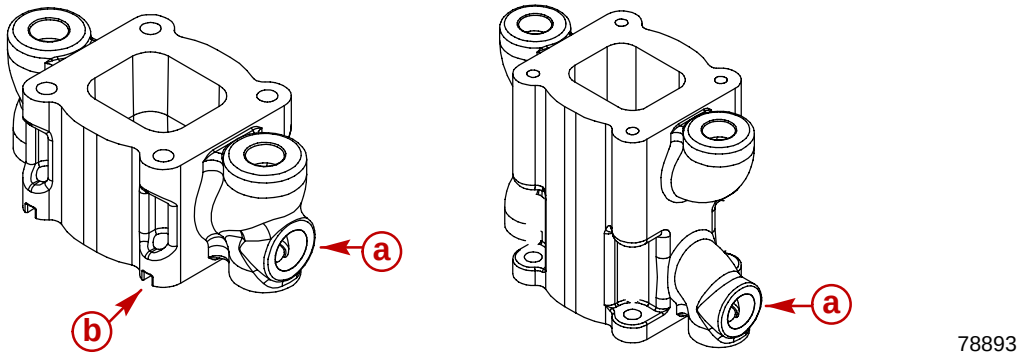
Model	Serial Number
Sterndrive (MCM) models	0M600000 Through 0M614999
Inboard and Tow Sports (MIE) models	0M317000 Through 0M389999

NOTE: *The engine may have been converted to warm riser; visually identify the water connection location in the riser.*

NOTE: *The position of the riser water port and castings are different between the cold riser model and the warm riser model.*

IMPORTANT: Service kits are available for the 76 mm (3 in.) and the 152 mm (6 in.) cold risers; use cold kits on original cold riser engines only. Refer to the 2003 and Newer *Mercury Precision Parts/Quicksilver Accessories Guide*.

Cold riser castings can be easily identified by the water ports and drain holes on the casting.



76 mm (3 in.) riser **152 mm (6 in.) riser**

a - Cold riser water port is positioned to the bottom side of casting, closest to exhaust manifold

b - Drain holes on bottom of 76 mm (3 in.) casting

Warm riser castings can be used on cold riser models, but require the use of the hose kits. The engine will have to be changed to warm risers.

NOTE: *Using Perfect Seal on water ports is a preventive measure for corrosion deterioration.*

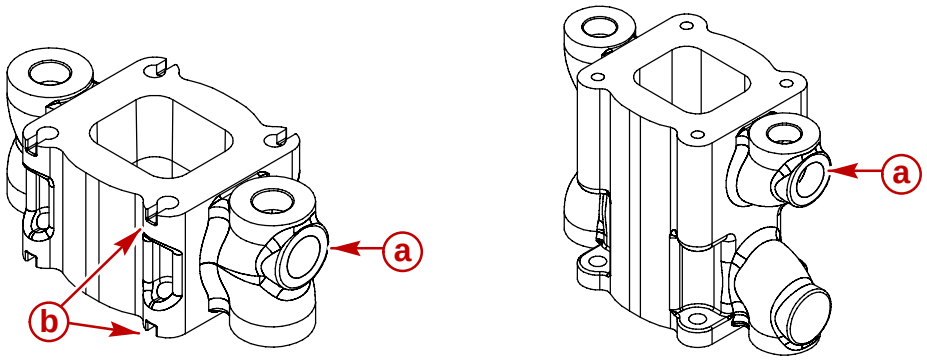
Description	Where Used	Part Number
Perfect Seal	Water ports	92-34227-1

Warm Riser Casting

Model	Serial Number
Sterndrive (MCM) models	0M615000 and Above
Inboard and Tow Sports (MIE) models	0M390000 and Above

NOTE: *The position of the threaded water port is different between the cold riser model and the warm riser model.*

IMPORTANT: The 76 mm (3 in.) and 152 mm (6 in.) warm riser identified is a new casting design and cannot be replaced with the previous Mercury MerCruiser riser castings. Riser castings used for the cold riser model cannot be used for warm riser models.



76 mm (3 in.) riser **152 mm (6 in.) riser**

a - Warm riser water port is positioned to the top side of casting, closest to exhaust elbow

b - Drain holes on top and bottom of 76 mm (3 in.) casting

NOTE: *Using Perfect Seal on water ports is a preventive measure for corrosion deterioration.*

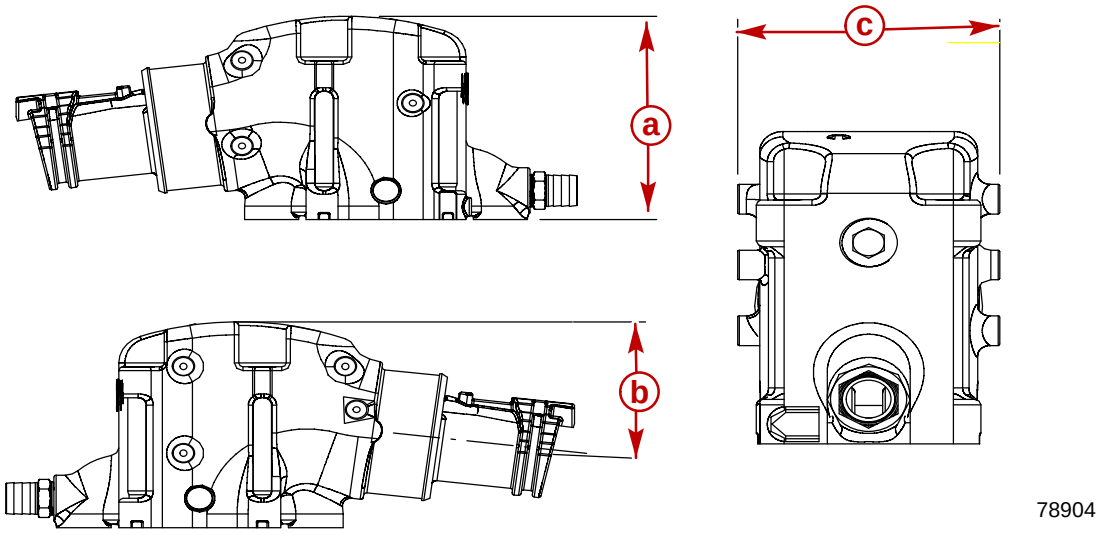
Description	Where Used	Part Number
Perfect Seal	Water ports	92-34227-1

Exhaust Elbow

NOTE: *All previous models used the early style 7 degree exhaust elbow.*

MCM Models And In-line Tow Sports Models

The 7 degree exhaust elbows identified are a new casting design and should not be replaced with previous Mercury MerCruiser elbow castings.

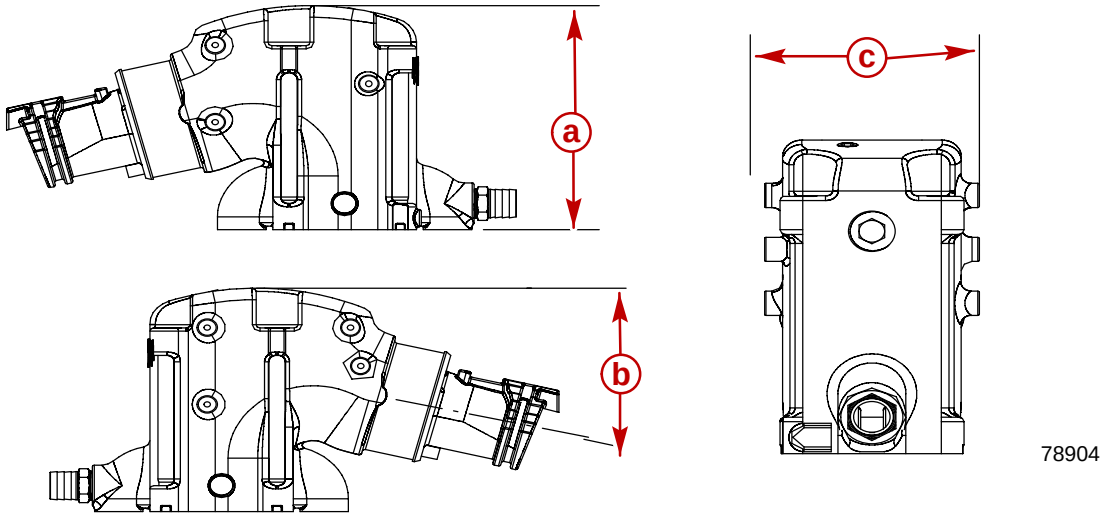


a - 16.9 cm (6-21/32 in.)
b - 7 degree
c - 12.0 cm (4-3/4 in.)

Inboard Models And V-Drive Tow Sports Models

IMPORTANT: Installation specifications on these models are covered in Section 2B.

The 14 degree exhaust elbows identified are a new casting design and should not be replaced with previous Mercury MerCruiser elbow castings.



a - 20.7 cm (8-5/32 in.)
b - 14 degree
c - 12.0 cm (4-3/4 in.)

Exhaust Elbow Fasteners

Assembly scenario	Engine Model	Fastener Description
Elbow to manifold or elbow to 152 mm (6 in.) riser	All MCM Models, and Tow Sports V-drive (7 degree elbow)	3/8-16 x 5-3/4 in. (14.6 cm) long hex flange head with pre-applied locking compound
Elbow and 76 mm (3 in.) riser to manifold	MCM models with 76 mm (3 in.) riser	3/8-16 x 9 in. (22.8 cm) long hex head with pre-applied locking compound and flat washer
152 mm (6 in.) riser to manifold	Any model with 152 mm (6 in.) riser	3/8-16 x 1 in. (25 mm) long hex flange head with pre-applied locking compound
Elbow to manifold or elbow to 152 mm (6 in.) riser	All Inboard models with 14 degree elbow (taller elbow)	3/8-16 x 7-1/2 in. (19.0 cm) long hex head with pre-applied locking compound and flat washer
Elbow and 76 mm (3 in.) riser to manifold	All Inboard models with 14 degree elbow (taller elbow) and 76 mm (3 in.) riser	3/8-16 x 10-1/2 in. (26.6 cm) long hex head with pre-applied locking compound and flat washer

IMPORTANT: To ensure correct torque, the exhaust elbow screws without a flanged head require that a specific flat washer be used in conjunction with the screw. If a flange head bolt is used, no washer is needed. Refer to the *Mercury Precision Parts/Quicksilver Accessories Guide.*

NOTES:

EXHAUST SYSTEM

Section 7C - Manifolds And Elbows With Dry Joint

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7
C

Models Covered

Dry Joint Models With Cold Risers

Dry Joint Models With Cold Risers	Serial Number
Sterndrive (MCM) models	0M600000 and Above
Inboard and Tow Sports (MIE) models	0M317000 and Above

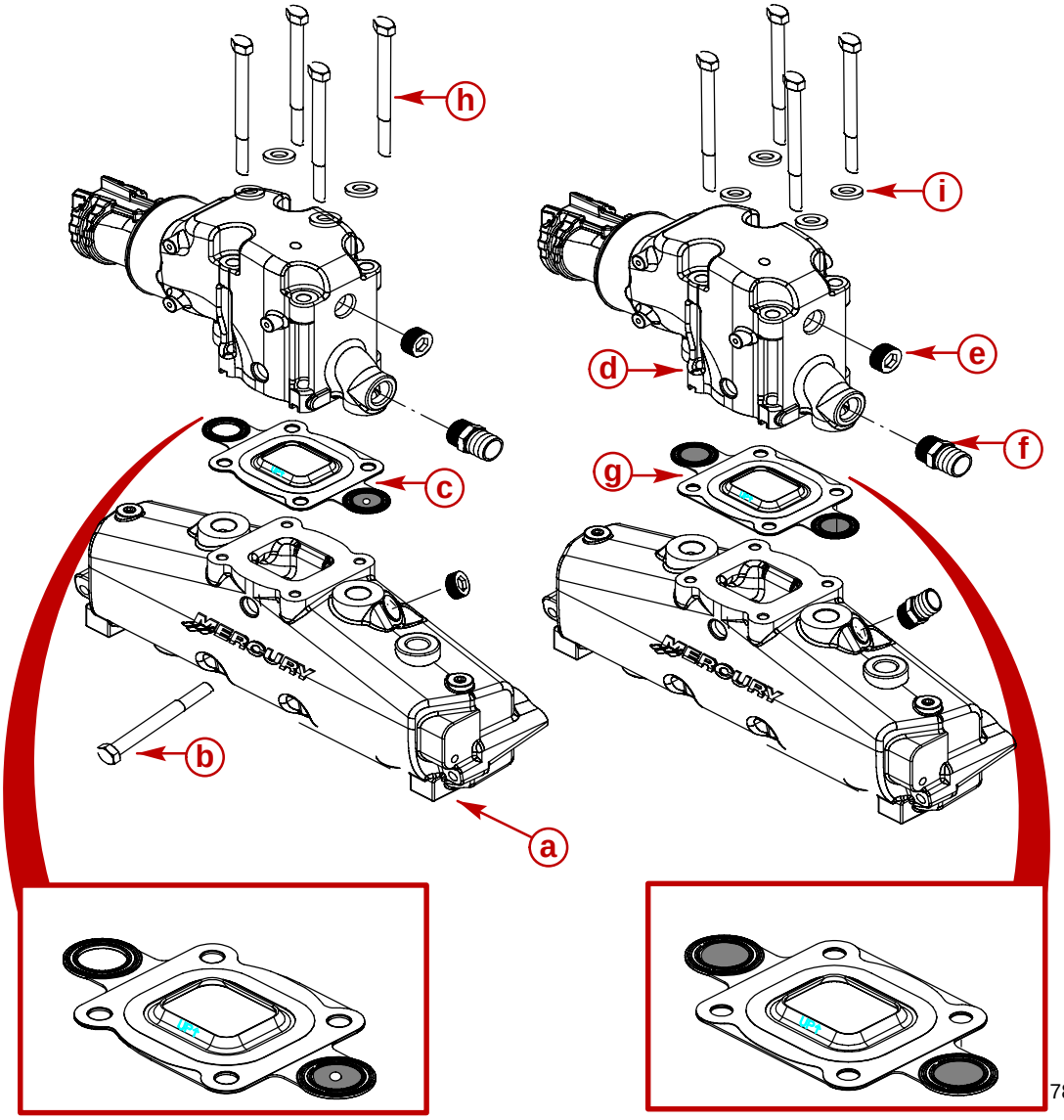
Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Perfect Seal	Edge of water ports on the exhaust manifold and exhaust elbow	92-34227-1
	Screw threads	
	Bare metal gasket sealing surface	
Loctite 567 PST Pipe Sealant	Hose fitting and pipe plug	92-809822

Equivalent products may be used.

Exploded View

Warm Manifolds



Seawater cooled assembly **Closed cooled assembly**

NOTE: *7 degree elbows shown, 14 degree elbow similar*

- **a** - Exhaust manifold
- **b** - Manifold to cylinder head bolt
- **c** - Restrictor gasket with turbulator (seawater cooled models)
- **d** - Exhaust elbow
- **e** - Pipe plug
- **f** - Hose fitting
- **g** - Block-off gasket with turbulator (closed cooled models)
- **h** - Exhaust elbow to exhaust manifold bolt
- **i** - Flat washer used with early 14 degree elbow (Refer to **Section 7B - Dry Joint Identification**)

NOTE: *Replacement fasteners "**h**" and "**i**" will be flange head bolts.*

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

Description		Nm	lb-in.	lb-ft
Exhaust elbow to exhaust manifold bolt or nut				
Tighten fasteners evenly using X pattern from corner to corner	First pass	9	84	
	Final pass	61		45
Exhaust manifold to cylinder head bolt		33.8		25
Exhaust manifold and exhaust elbow pipe plug		50		37
Exhaust manifold and exhaust elbow hose fitting		50		37

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables from the battery.

⚠ CAUTION

Avoid severe engine damage. Exhaust elbows and manifolds MUST BE drained to prevent coolant / water from entering combustion chambers when exhaust elbows are removed.

1. **Seawater Cooled Models:** Drain the seawater section of the engine.
1. **Closed Cooled Models:** Drain the coolant section of the engine. Refer to **Section 6C**.
2. Disconnect the engine exhaust hoses. Retain fasteners.
3. Disconnect all hoses from the exhaust manifold and exhaust elbow. Retain fasteners.
4. Remove and retain any items or components that are mounted to the manifold and the exhaust elbow of the engine.
5. Remove the exhaust elbow. Retain fasteners.

NOTE: *Some engines were built with hex head bolts and washers.*

6. Remove the exhaust manifold. Retain fasteners.
7. Discard used gaskets.

Cleaning And Inspection

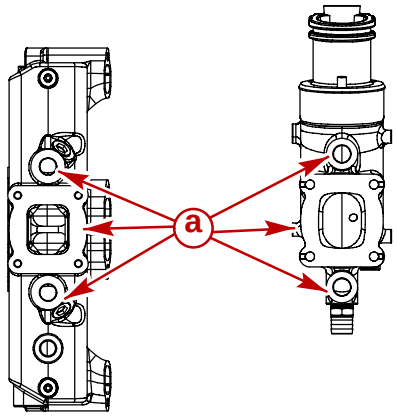
1. Clean the gasket material from all surfaces and wash the parts in solvent.
2. Inspect the water passages for foreign material. The passages must be clean for efficient cooling.

NOTE: *If more thorough inspection is desired, the pipe plugs may be removed from the exhaust manifold and the exhaust elbow.*

IMPORTANT: If the pipe plugs are removed, coat the threads with sealant before reinstalling.

Description	Where Used	Part Number
Loctite 567 Pipe Sealant	Pipe plug	92-809822

3. Inspect the manifold, elbow, and riser for cracks.
4. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches or water and exhaust leaks may result.
5. Inspect for damaged metal caused by saltwater or exhaust gas corrosion in the manifold, elbow, and riser.
6. Measure the surface flatness of all gasket surfaces on the manifold, elbow, and riser.



78748

a - Gasket sealing surface

NOTE: *Only use this specification if the gasket surfaces on used exhaust components have to be machined to remove minor corrosion.*

Description		mm (in.)
Surface Flatness	Maximum overall difference	0.07 (0.003)

NOTE: *The maximum material that can be removed is 0.25 mm (0.010 in.). When torquing the attaching bolts, ensure that they are not contacting the bottom of the threaded hole in the manifold.*

NOTE: *Gasket is not reusable. Inspect for proper gasket replacement before disassembly and assembly.*

7. Replace all damaged components.

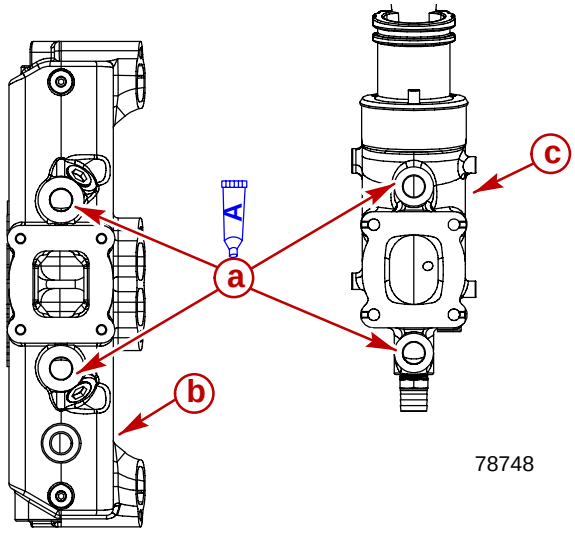
Reassembly

IMPORTANT: The edge of the water ports on all cast iron parts must be coated with Perfect Seal during assembly.

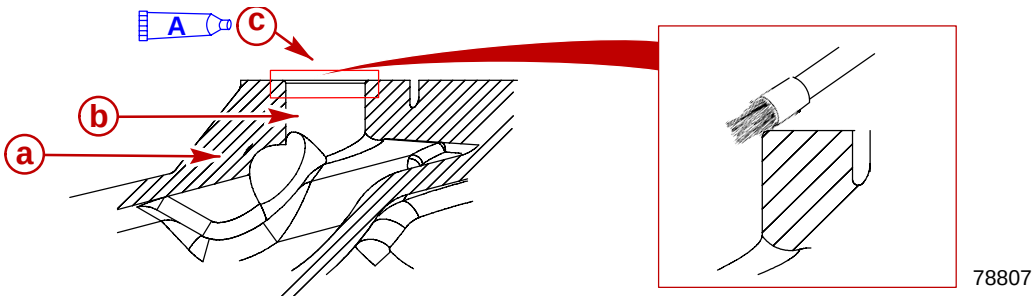
IMPORTANT: If bare metal is present on the gasket sealing surface, Perfect Seal should be applied to that area before assembly.

Description	Where Used	Part Number
Perfect Seal	Bare metal gasket sealing surface	92-34227-1

1. If exhaust elbow assembly is disassembled or risers are added, apply sealant to edge of all water ports (exhaust manifold, both sides of the riser, and exhaust elbow).



a - Water ports
b - Exhaust manifold
c - Exhaust elbow



a - Exhaust manifold (cross section)
b - Exhaust manifold water port
c - Edge of water port (area to apply sealant)

Description		Where Used	Part Number
A	Perfect Seal	Edge of water ports on the exhaust manifold and exhaust elbow	92-34227-1

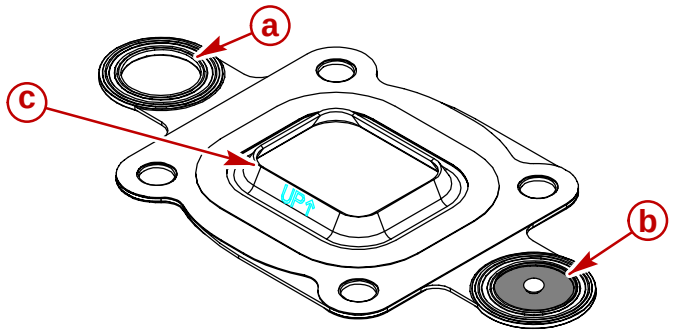
Gasket Application

Restrictor Gasket

Model	Description
Seawater cooled	Restrictor gasket

IMPORTANT: On engines without risers, the restrictor gasket must be placed between the exhaust manifold and the exhaust elbow.

IMPORTANT: The restrictor end of the gasket must be positioned to the seawater inlet side of the exhaust elbow.



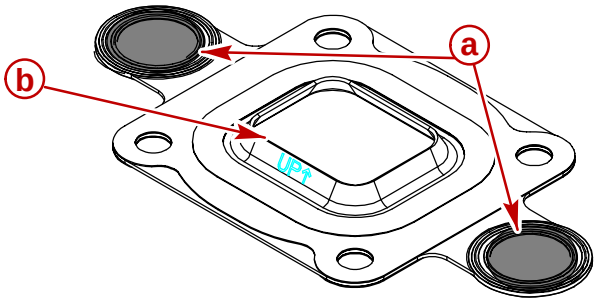
78805

a - Full flow passage
b - Restricted flow passage
c - Turbulator oriented up

Block-Off Gasket

Model	Description
Closed cooled	Block-off gasket

IMPORTANT: On engines without risers, the block-off gasket must be placed between the exhaust manifold and the exhaust elbow.



78806

a - No opening for coolant flow
b - Turbulator oriented up

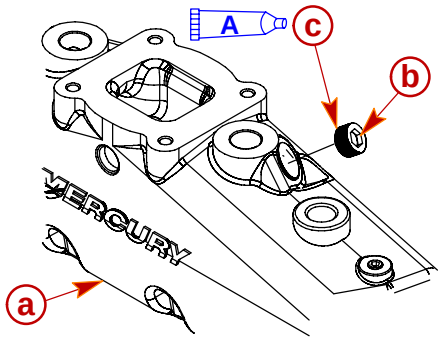
Installation

⚠ CAUTION

Avoid severe engine damage. The correct turbulator gasket MUST BE properly installed to avoid overheating due to insufficient water flow or coolant loss through exhaust.

IMPORTANT: Refer to Section 7D - Cold Riser Models With Dry Joint and Section 7E - Warm Riser Models With Dry Joint if exhaust risers are used.

1. **Seawater Cooled Models:** Apply sealant to threads of pipe plug and install to exhaust manifold.



78887

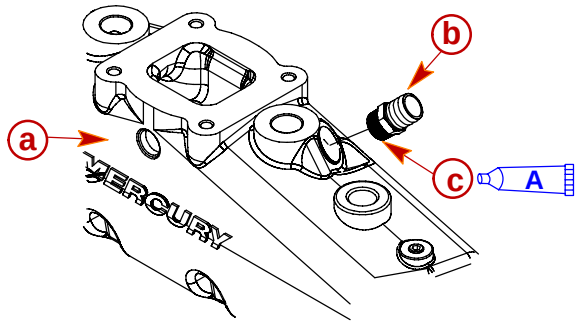
a - Exhaust manifold
b - Pipe plug
c - Sealant applied to threads

Description		Where Used	Part Number
A	Loctite 567 PST Pipe Sealant	Pipe plug	92-809822

2. Torque pipe plug.

Description	Nm	lb-in.	lb-ft
Exhaust manifold and exhaust elbow pipe plug	50		37

3. **Closed Cooled Models:** Apply sealant to threads of hose fitting and install to exhaust manifold.



78887

a - Exhaust manifold
b - Hose fitting
c - Sealant applied to threads

Description		Where Used	Part Number
A	Loctite 567 Pipe Sealant	Hose fitting	92-809822

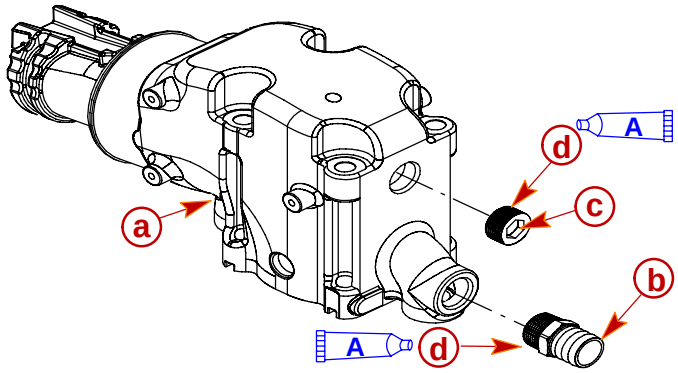
4. Torque hose fitting.

Description	Nm	lb-in.	lb-ft
Exhaust manifold and exhaust elbow pipe plug	50		37

5. Using new exhaust manifold gasket, install exhaust manifold to cylinder head. Torque fasteners.

Description	Nm	lb-in.	lb-ft
Exhaust manifold to cylinder head bolt	33.8		25

6. Apply sealant to threads of hose fitting and pipe plug and install in exhaust elbow.



78893

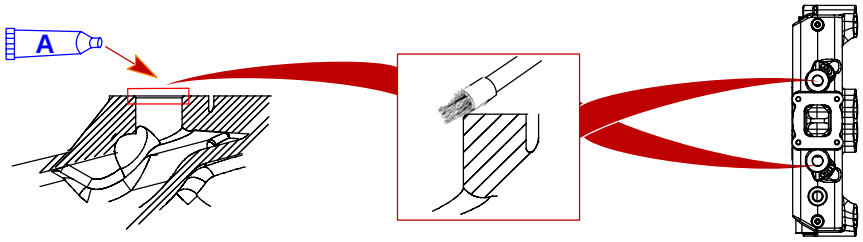
a - Exhaust elbow
b - Hose fitting
c - Pipe plug
d - Sealant applied to threads

Description		Where Used	Part Number
A	Loctite 567 Pipe Sealant	Hose fitting and pipe plug	92-809822

7. Torque hose fitting and pipe plug.

Description	Nm	lb-in.	lb-ft
Exhaust manifold and exhaust elbow pipe plug	50		37

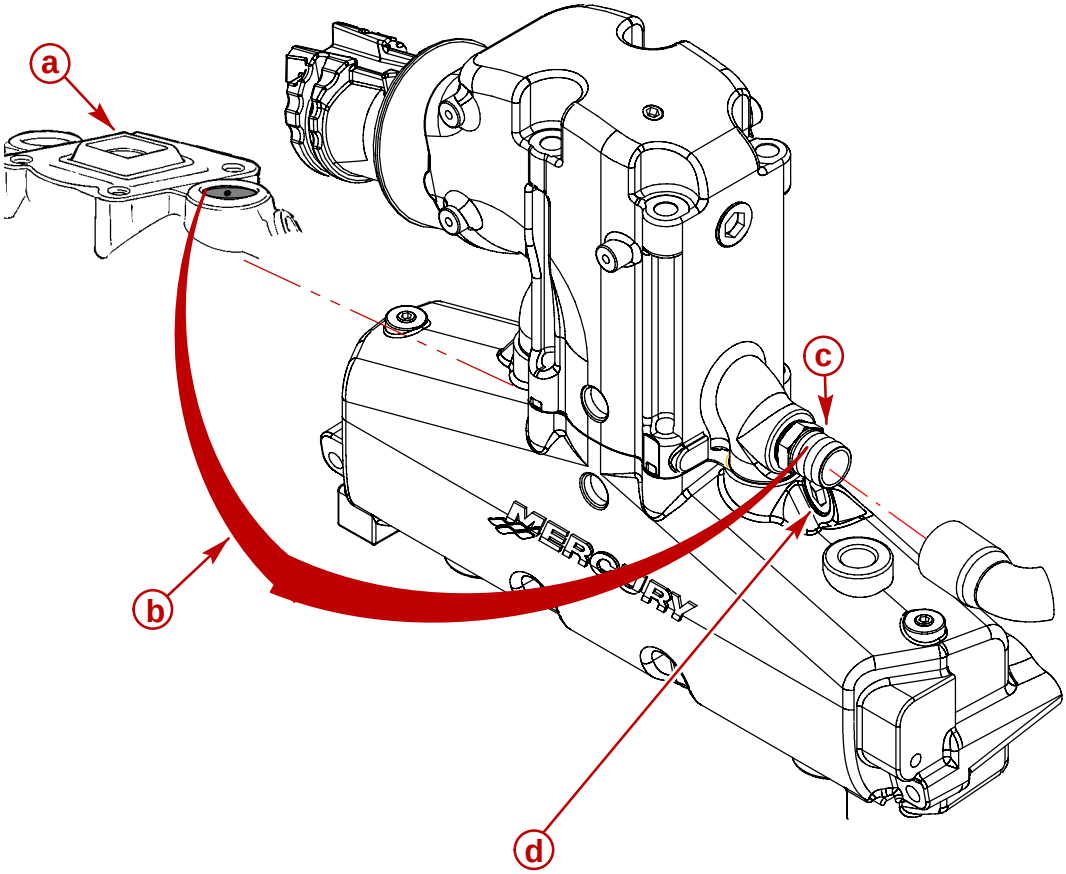
8. Apply sealant to the edge of each of the 2 water ports located on the exhaust manifold.



78807

Description		Where Used	Part Number
A	Perfect Seal	Edge of water ports on the exhaust manifold and exhaust elbow	92-34227-1

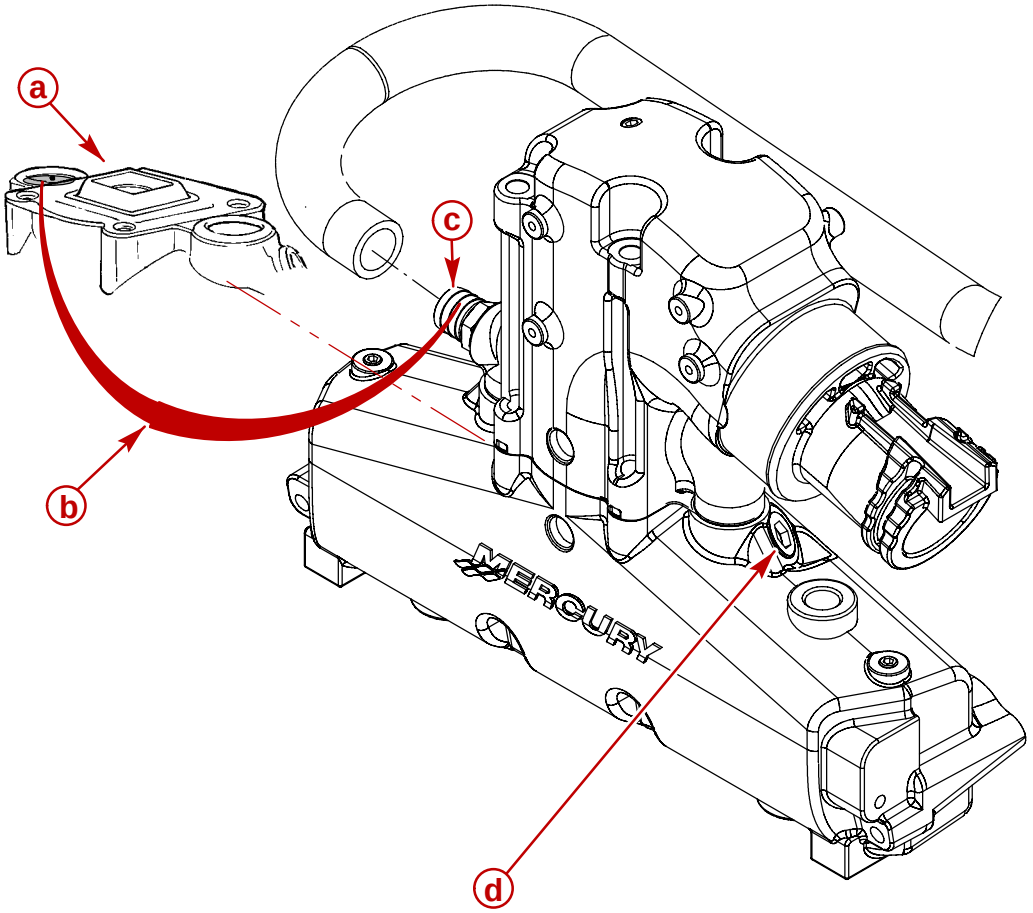
9. **Seawater Cooled Models:** Place the restrictor gasket on the exhaust manifold with the side marked “UP” visible. Ensure that the restricted water port of restrictor gasket is on the same side as the hose fitting of the exhaust elbow.



78910

MCM and MIE in-line exhaust seawater cooled model

- **a** - Restrictor gasket positioned between exhaust manifold and exhaust elbow
- **b** - Restricted water port of gasket is in line with hose fitting of exhaust elbow
- **c** - Exhaust elbow inlet water port with hose fitting
- **d** - Exhaust manifold outlet water port with pipe plug

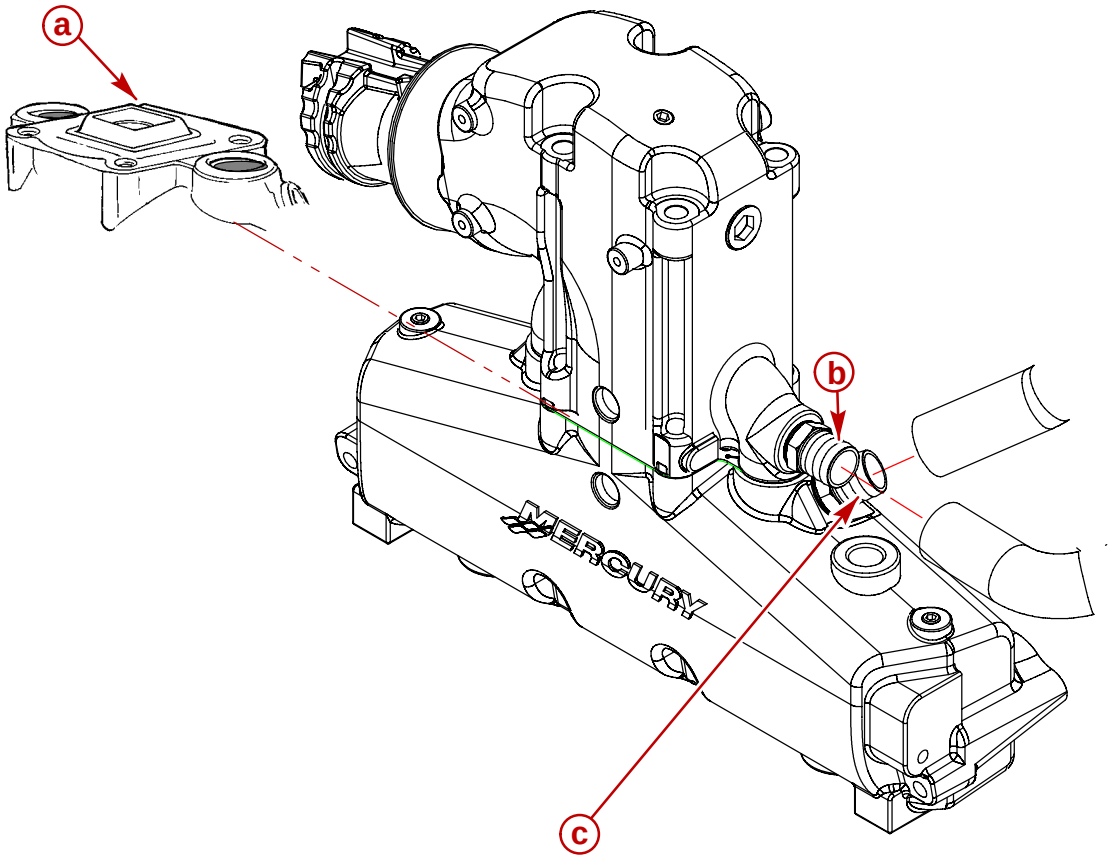


78889

MIE V-drive seawater cooled model

- **a** - Restrictor gasket positioned between exhaust manifold and exhaust elbow
- **b** - Restricted water port of gasket is in line with hose fitting of exhaust elbow
- **c** - Exhaust elbow inlet water port with hose fitting
- **d** - Exhaust manifold outlet water port with pipe plug

10. **Closed Cooled Models:** Place the block-off gasket on the exhaust manifold with the side marked “UP” visible.

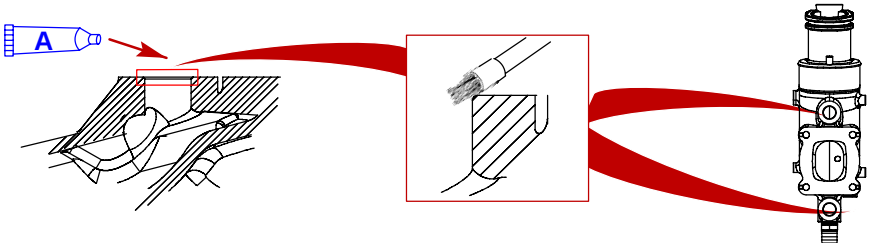


78890

MCM and MIE in-line exhaust closed cooled model

- **a** - Block-off gasket positioned between exhaust manifold and exhaust elbow
- **b** - Exhaust elbow inlet water port with hose fitting
- **c** - Exhaust manifold outlet coolant port with hose fitting

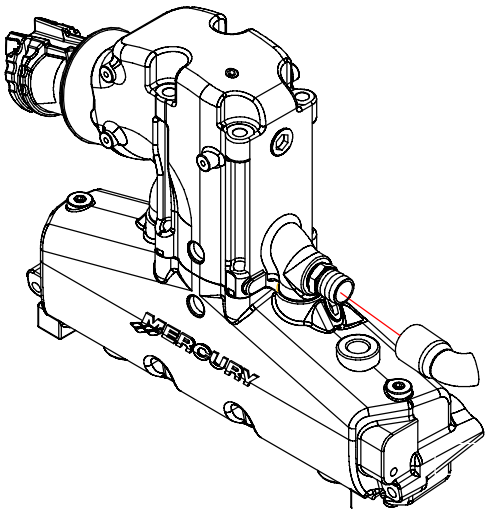
11. Apply sealant to the edge of each of the 2 water ports located on the exhaust elbow.



78807

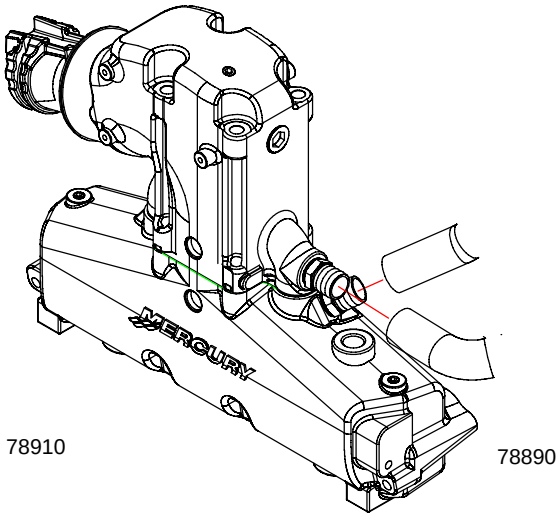
Description		Where Used	Part Number
A	Perfect Seal	Edge of water ports on the exhaust manifold and exhaust elbow	92-34227-1

12. Place the exhaust elbow on the exhaust manifold.



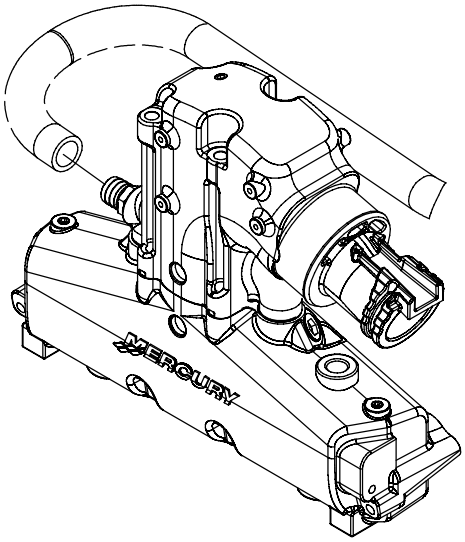
78910

Seawater cooled in-line exhaust model



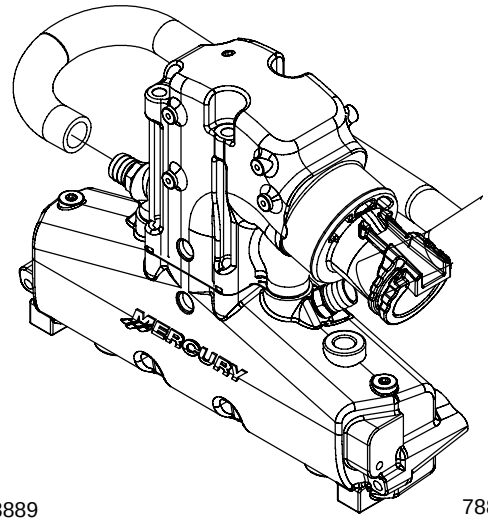
78890

Closed cooled in-line exhaust model



78889

Seawater cooled V-drive model



78888

Closed cooled V-drive model

IMPORTANT: To ensure correct torque, the exhaust elbow screws without a flanged head require that a specific flat washer be used in conjunction with the screw. If a flange head bolt is used, no washer is needed. Refer to the *Mercury Precision Parts/Quicksilver Accessories Guide.*

13. If applicable, assemble washers to the exhaust elbow bolts.
14. Apply sealant to exhaust elbow bolt threads and hand-start to temporarily secure the assembly.

Description	Where Used	Part Number
Perfect Seal	Exhaust elbow bolt threads	92-34227-1

15. Align the exhaust elbow to the engine exhaust system.

NOTE: *Gasket is not reusable. Inspect for proper gasket and component position before torquing.*

16. Torque the exhaust elbow fasteners.

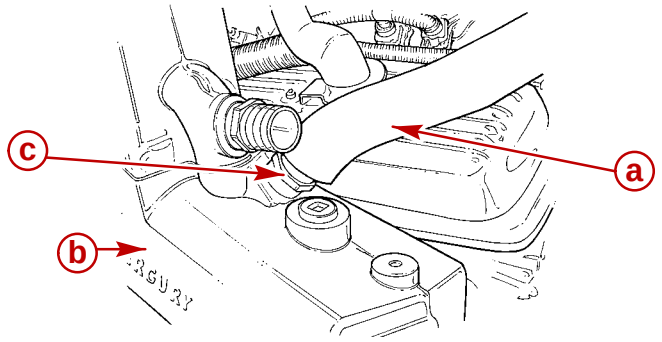
Description		Nm	lb-in.	lb-ft
Exhaust elbow to exhaust manifold bolt or nut				
Tighten fasteners evenly using X pattern from corner to corner	First pass	9	84	
	Final pass	61		45

17. **Seawater Cooled Models:** Connect the engine water hoses to the exhaust elbows and tighten hose clamps securely.

⚠ CAUTION

Avoid severe engine damage due to improper hose connection, causing coolant to discharge out exhaust. Do not connect the engine coolant hose to the exhaust elbow.

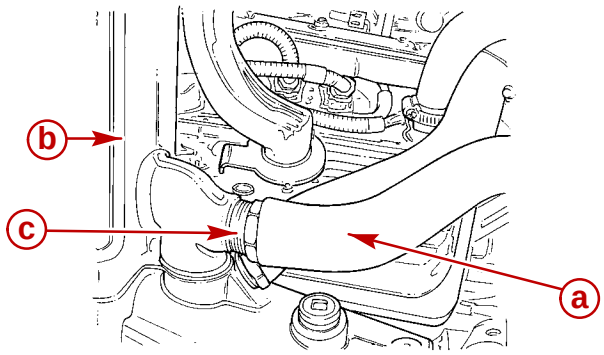
18. **Closed Cooled Models:** Connect the engine coolant hose from the thermostat housing to the hose fitting of the top of the exhaust manifold. Tighten hose clamps securely.



78758

a - Engine coolant hose
b - Exhaust manifold
c - Hose fitting of the exhaust manifold

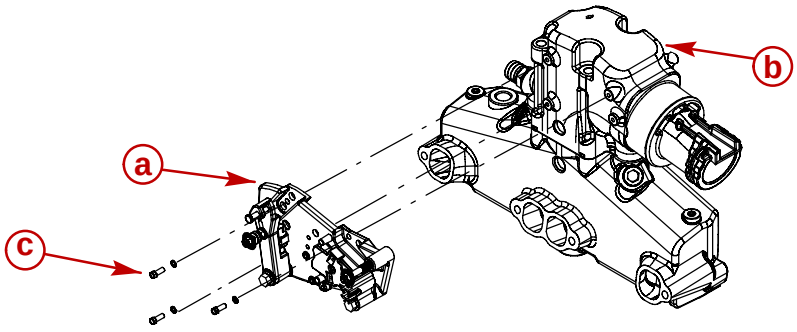
19. **Closed Cooled Models:** Connect the engine water hose from the heat exchanger to the exhaust elbow and tighten hose clamps securely.



78759

a - Engine water hose
b - Exhaust elbow
c - Hose fitting of the exhaust elbow

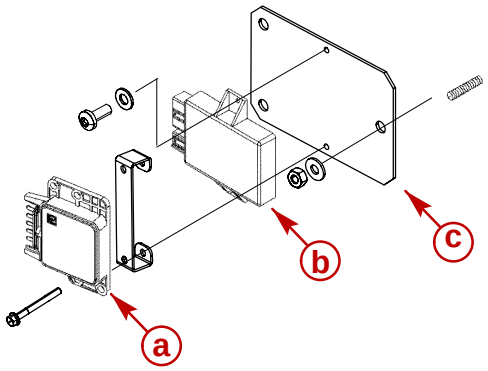
20. **MCM Models:** Install shift plate assembly on exhaust elbow.



78788

a - Exhaust elbow
b - Shift bracket
c - Shift bracket to exhaust elbow screw

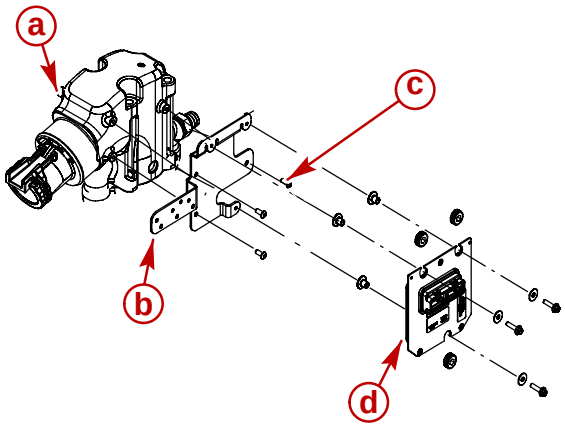
21. **MCM Models:** Connect both shift cables.
22. **All Models Except Scorpion:** Install ECM and ECM bracket on exhaust elbow.



79370

Carbureted models

a - Knock module
b - Ignition module
c - Drop-down bracket



78685

MPI models

a - Exhaust elbow
b - ECM bracket
c - Short screw
d - ECM

23. Secure the engine exhaust system.
24. Install any additional components removed during disassembly.
25. **Closed Cooled Models:** Fill closed cooling system to operating level. Refer to **Section 6C**.
26. Reconnect the battery cables to the battery. Tighten securely.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

27. Supply cooling water to the engine.
28. Start the engine and check for exhaust and water leaks.

NOTES:

EXHAUST SYSTEMS

Section 7D - Cold Risers With Dry Joint

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7 D

Models Covered

Dry Joint Models With Cold Risers

Model	Serial Number or Year
Sterndrive (MCM) models	0M600000 Through 0M614999
Inboard and Tow Sports (MIE) models	0M317000 Through 0M389999

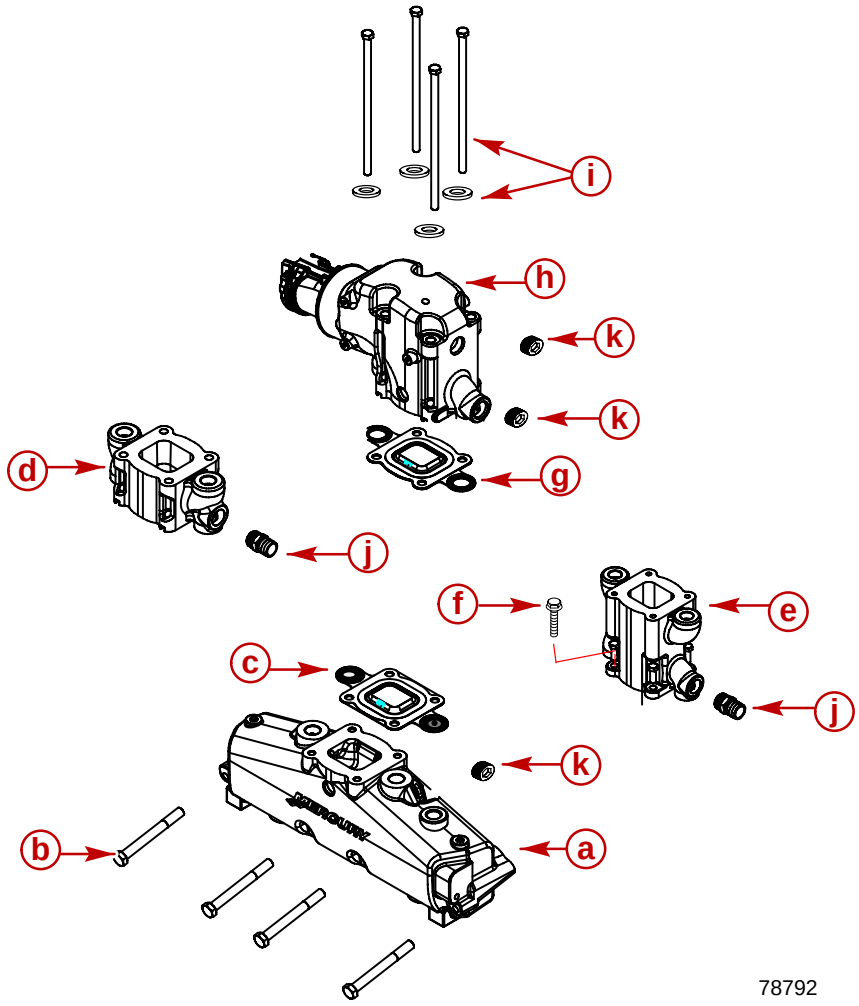
Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227-1
	Exhaust elbow bolt threads	
Loctite 567 PST Pipe Sealant	Hose fitting and pipe plug	92-809822

Equivalent products may be used.

Exploded View

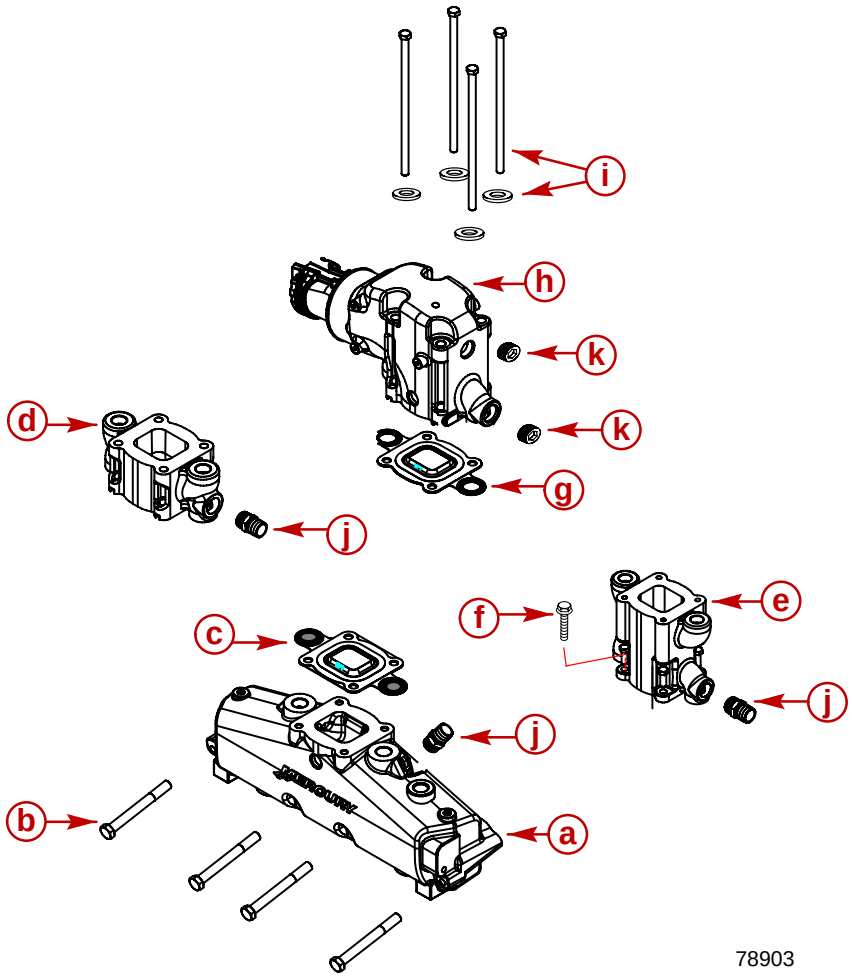
Seawater Cooled Models



a - Exhaust manifold
b - Manifold to cylinder head bolt (4)
c - Restrictor gasket, with turbulator (seawater cooled models)
d - 76 mm (3 in.) cold riser
e - 152 mm (6 in.) cold riser
f - Riser to exhaust manifold screw (4)
g - Full flow gasket, with turbulator
h - Exhaust elbow
i - Exhaust elbow to riser or exhaust manifold bolt and washer (4 each)
j - Hose fitting
k - Pipe plug

NOTE: *Replacement fasteners "**i**" will be flange head bolts.*

Closed Cooled Models



a - Exhaust manifold
b - Manifold to cylinder head bolt (4)
c - Block-off gasket, with turbulator (closed cooled models)
d - 76 mm (3 in.) cold riser
e - 152 mm (6 in.) cold riser
f - Riser to exhaust manifold bolt (4)
g - Full flow gasket, with turbulator
h - Exhaust elbow
i - Exhaust elbow to riser or exhaust manifold screw and washer (4 each)
j - Hose fitting
k - Pipe plug

NOTE: *Replacement fasteners "**i**" will be flange head bolts.*

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

Description		Nm	lb-in.	lb-ft
Exhaust elbow to riser and riser to exhaust manifold bolt or nut				
Tighten fasteners evenly using X pattern from corner to corner	First pass	9	84	
	Final pass	61		45
Exhaust manifold and exhaust elbow pipe plug		50		37
Exhaust manifold and exhaust elbow hose fitting		50		37

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire, or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables from the battery.

⚠ CAUTION

Avoid severe engine damage. Exhaust elbows and manifolds MUST BE drained to prevent coolant / water from entering combustion chambers when exhaust elbows are removed.

1. **Seawater Cooled Models:** Drain the seawater section of the engine.

1. **Closed Cooled Models:** Drain the coolant section of the engine. Refer to **Section 6C**.
2. Disconnect the engine exhaust hoses. Retain fasteners.
3. Disconnect all hoses from the exhaust manifold, riser, and exhaust elbow. Retain fasteners.
4. Remove and retain any items or components that are mounted to the exhaust manifold, riser, and the exhaust elbow of the engine.
5. Remove the exhaust elbow and riser. Retain fasteners.
6. Remove the exhaust manifold. Retain fasteners.
7. Discard used gaskets.

Cleaning And Inspection

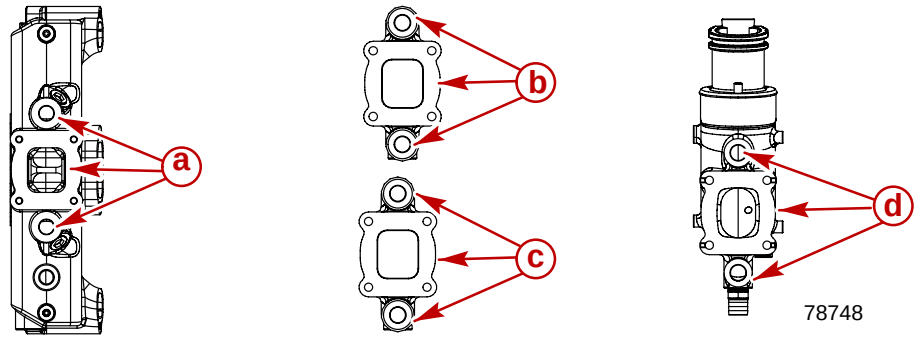
1. Clean the gasket material from all surfaces and wash the parts in solvent.
2. Inspect the water passages for foreign material. The passages must be clean for efficient cooling.

NOTE: *If more thorough inspection is desired, the pipe plugs may be removed from the exhaust manifold and the exhaust elbow.*

IMPORTANT: If the pipe plugs are removed, coat the threads with sealant before reinstalling.

Description	Where Used	Part Number
Loctite 567 PST Pipe Sealant	Pipe plug	92-809822

3. Inspect the manifold, elbow, and riser for cracks.
4. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches or water and exhaust leaks may result.
5. Inspect for damaged metal caused by saltwater or exhaust gas corrosion in the manifold, elbow, and riser.
6. Measure the surface flatness of all gasket surfaces on the manifold, elbow, and riser.



a - Exhaust manifold gasket sealing surface
b - Riser gasket sealing surface on top side
c - Riser gasket sealing surface on bottom side
d - Exhaust elbow gasket sealing surface

NOTE: *Only use this specification if the gasket surfaces on used exhaust components have to be machined to remove minor corrosion.*

Description		mm (in.)
Surface Flatness	Maximum overall difference	0.07 (0.003)

NOTE: *The maximum material that can be removed is 0.25 mm (0.010 in.). When torquing the attaching bolts, ensure that they are not contacting the bottom of the threaded hole in the manifold.*

NOTE: *Gasket is not reusable. Inspect for proper gasket replacement before disassembly and assembly.*

7. Replace all damaged components.

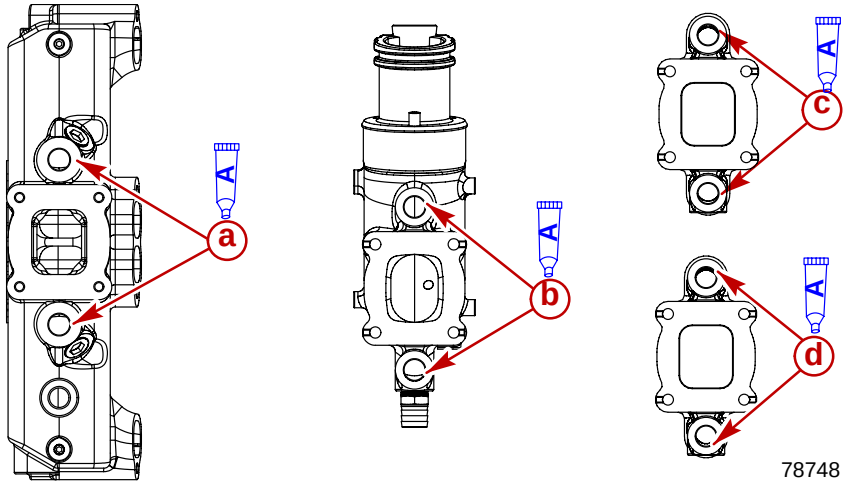
Reassembly

IMPORTANT: The edge of the water ports on all cast iron parts must be coated with Perfect Seal during assembly.

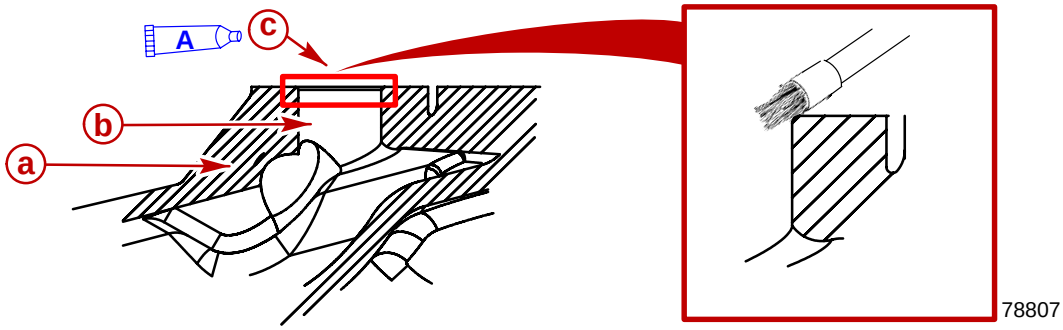
IMPORTANT: If bare metal is present on the gasket sealing surface, Perfect Seal should be applied to that area before assembly.

Description	Where Used	Part Number
Perfect Seal	Bare metal gasket sealing surface	92-34227-1

1. If exhaust elbow assembly is disassembled or risers are added, apply sealant to edge of all water ports (exhaust manifold, both sides of the riser, and exhaust elbow).



a - Exhaust manifold water port sealing surface
b - Exhaust elbow water port sealing surface
c - Riser water port sealing surface on top side
d - Riser water port sealing surface on bottom side



a - Exhaust manifold (cross section)
b - Exhaust manifold water port
c - Edge of water port (area to apply sealant)

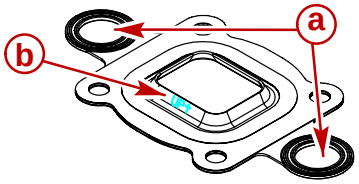
Description		Where Used	Part Number
A	Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227-1

Gasket Application

Full Flow Gasket

Model	Description
Engines with risers	Full flow gasket

IMPORTANT: On cold riser models, the full flow gasket must be placed between riser and exhaust elbow.



78804

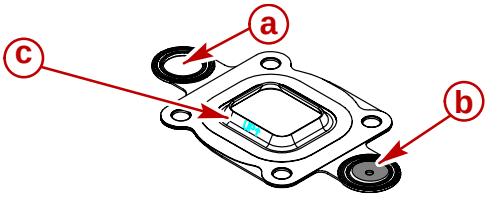
a - Passages fully open
b - Turbulator oriented up

Restrictor Gasket

Model	Description
Seawater cooled	Restrictor gasket

IMPORTANT: On cold riser models, the restrictor gasket must be placed between the exhaust manifold and the riser.

IMPORTANT: The restrictor end of the gasket must be positioned to the seawater inlet side of the exhaust elbow.

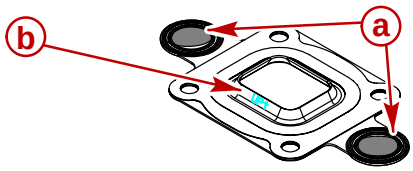


78805

a - Full flow passage
b - Restricted flow passage
c - Turbulator oriented upBlock-Off Gasket

Model	Description
Closed cooled	Block-off gasket

IMPORTANT: On cold riser models, the block-off gasket must be placed between the exhaust manifold and the riser.



78806

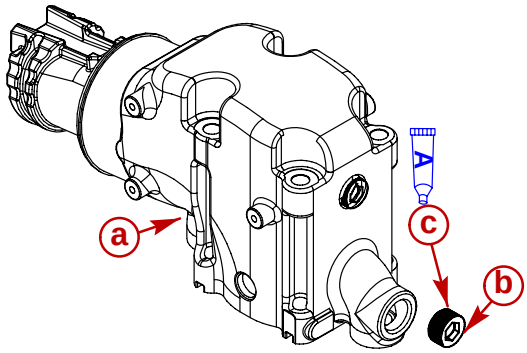
a - No opening for water flow
b - Turbulator oriented up

Installation

⚠ CAUTION

Avoid severe engine damage. The correct turbulator gasket MUST BE properly installed to avoid overheating due to insufficient water flow or coolant loss through exhaust.

1. Apply sealant to the threads of the pipe plug and install into the exhaust elbows.



78893

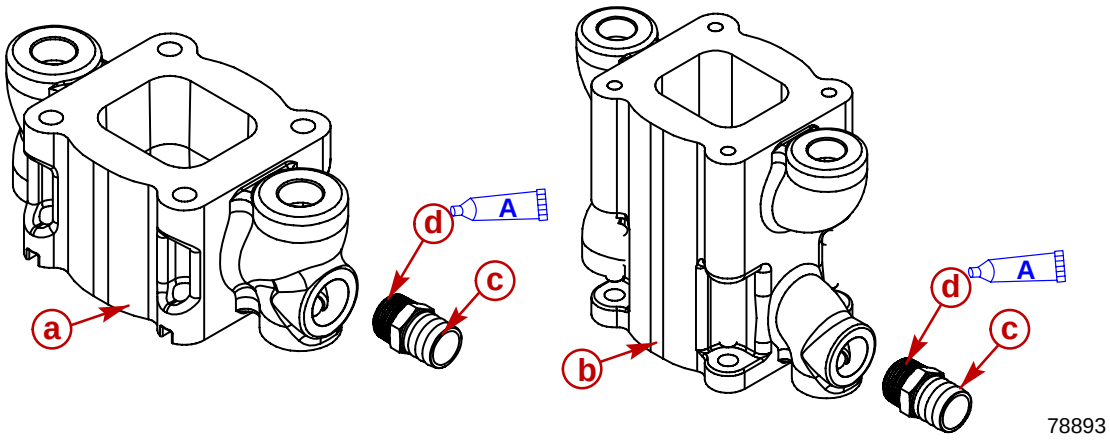
a - Exhaust elbow
b - Pipe plug
c - Sealant applied to threads

Description		Where Used	Part Number
A	Loctite 567 PST Pipe Sealant	Hose fitting	92-809822

2. Torque pipe plug.

Description	Nm	lb-in.	lb-ft
Exhaust manifold and exhaust elbow pipe plug	50		37

3. Apply sealant to the threads of the hose fitting and install into the risers.



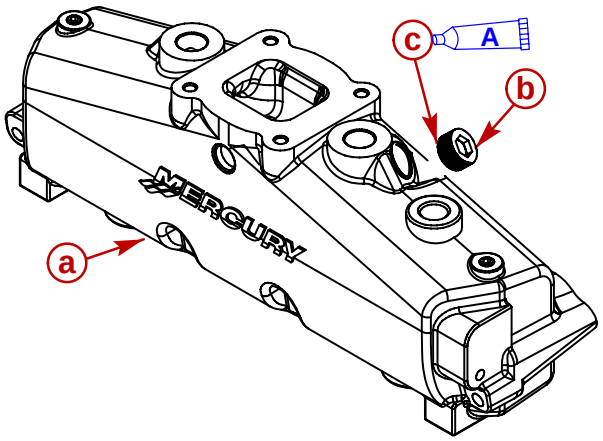
a - 76 mm (3 in.) riser
b - 152 mm (6 in.) riser
c - Hose fitting
d - Sealant applied to threads

Description		Where Used	Part Number
A	Loctite 567 PST Pipe Sealant	Hose fitting	92-809822

4. Torque hose fitting.

Description	Nm	lb-in.	lb-ft
Exhaust manifold and exhaust elbow hose fitting	50		37

5. **Seawater Cooled Models:** Apply sealant to the threads of the pipe plug and install into the exhaust manifold.



78893

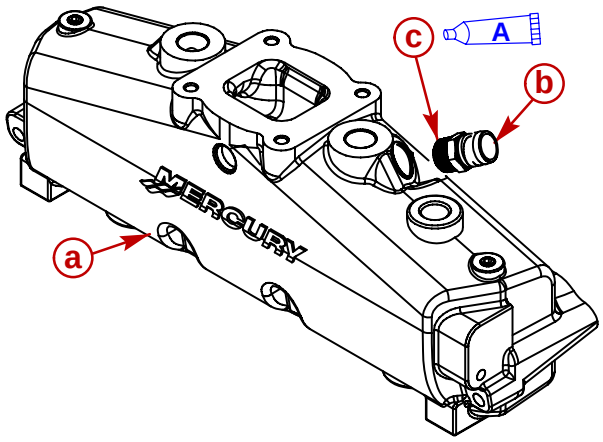
a - Exhaust manifold
b - Pipe plug
c - Sealant applied to threads

Description		Where Used	Part Number
A	Loctite 567 PST Pipe Sealant	Hose fitting	92-809822

6. Torque pipe plug.

Description	Nm	lb-in.	lb-ft
Exhaust manifold and exhaust elbow pipe plug	50		37

7. **Closed Cooled Models:** Apply sealant to the threads of the hose fitting and install into the exhaust manifold.



78893

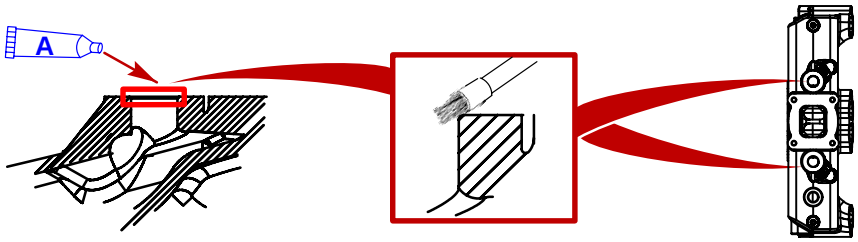
a - Exhaust manifold
b - Hose fitting
c - Sealant applied to threads

Description		Where Used	Part Number
A	Loctite 567 PST Pipe Sealant	Hose fitting	92-809822

8. Torque hose fitting.

Description	Nm	lb-in.	lb-ft
Exhaust manifold and exhaust elbow hose fitting	50		37

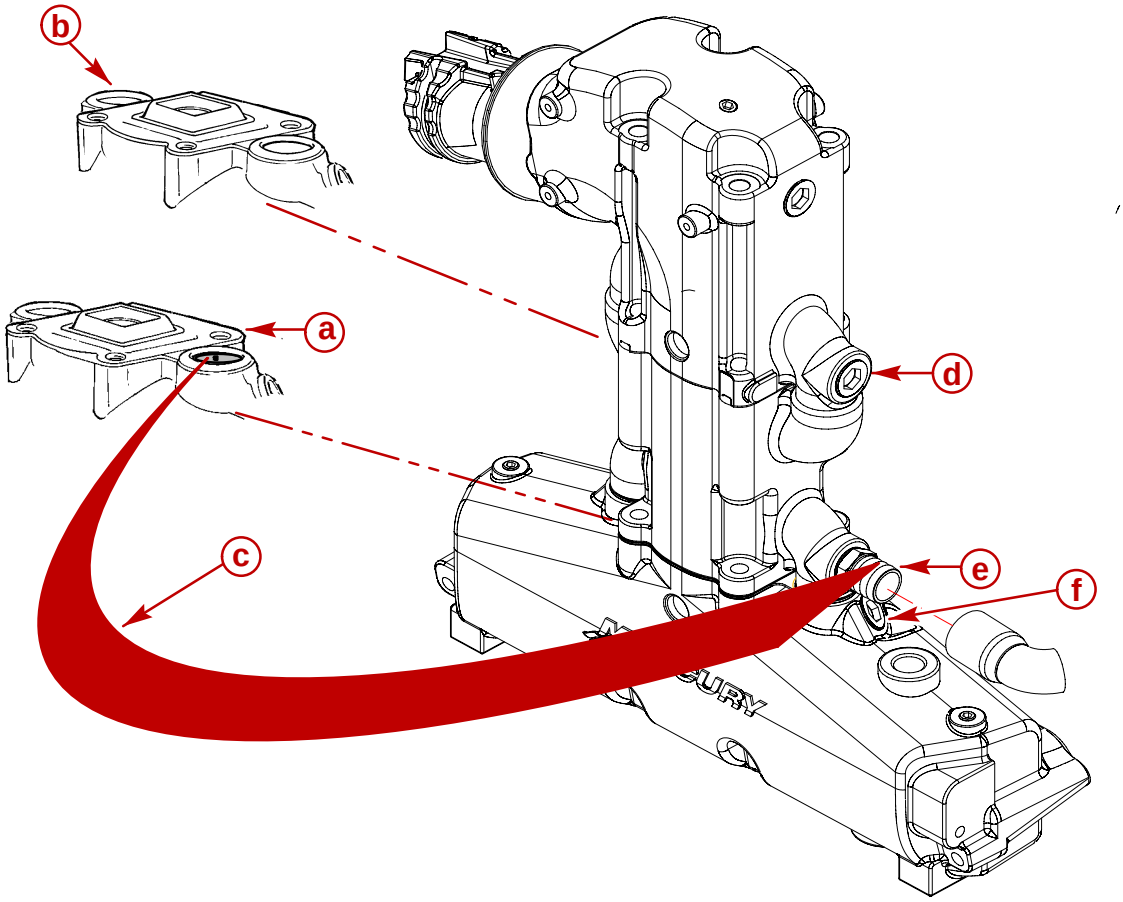
9. Apply sealant to the edge of each of the 2 water ports located on the exhaust manifold.



78807

Description		Where Used	Part Number
A	Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227-1

10. **Seawater Cooled Models:** Place the restrictor gasket on the exhaust manifold with the side marked “UP” visible. Ensure that the restricted water port of restrictor gasket is on the same side as the hose fitting of the riser.

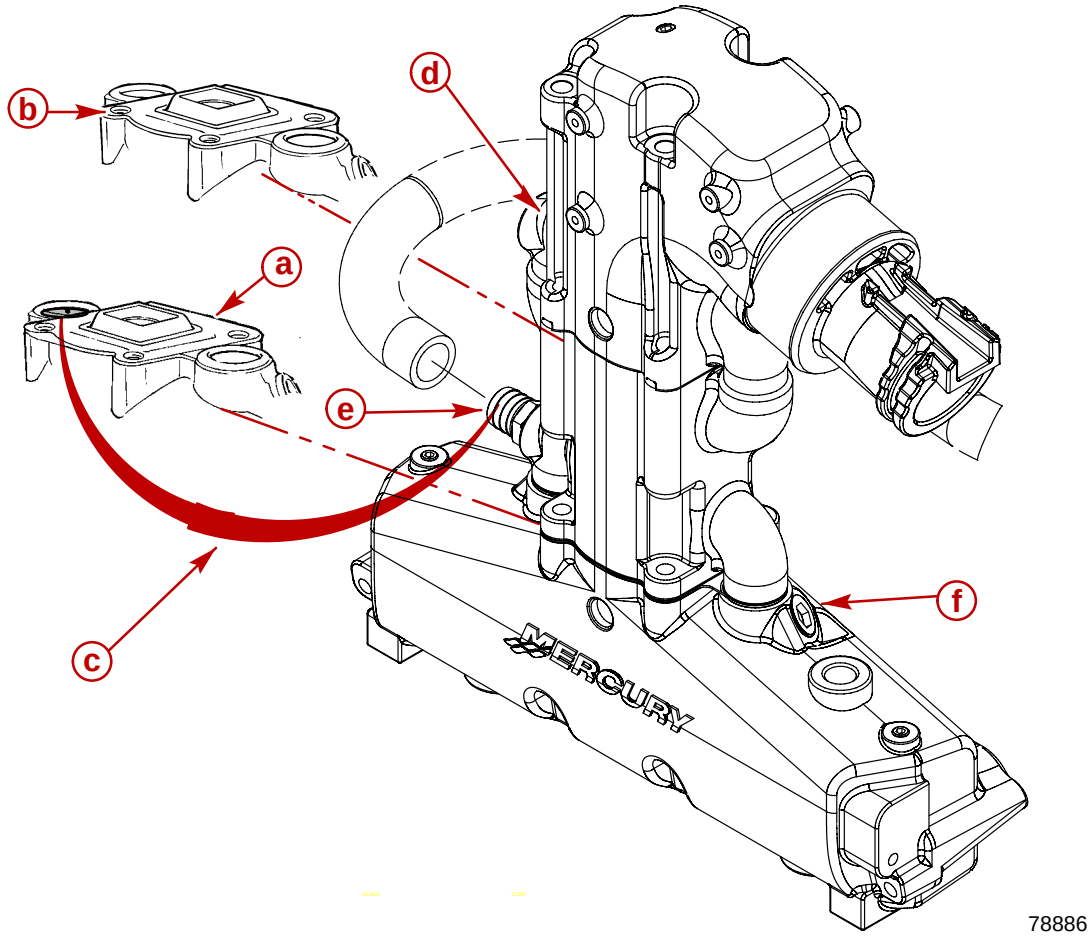


78892

MCM and MIE in-line exhaust seawater cooled model

- **a** - Restrictor gasket positioned between exhaust manifold and riser
- **b** - Full flow gasket positioned between riser and exhaust elbow
- **c** - Restricted water port of gasket is in line with hose fitting of riser
- **d** - Exhaust elbow inlet water port with pipe plug
- **e** - Riser inlet water port with hose fitting
- **f** - Exhaust manifold outlet water port with pipe plug

NOTE: *For the V-drive model, the riser has been turned in-line with the exhaust elbow.*

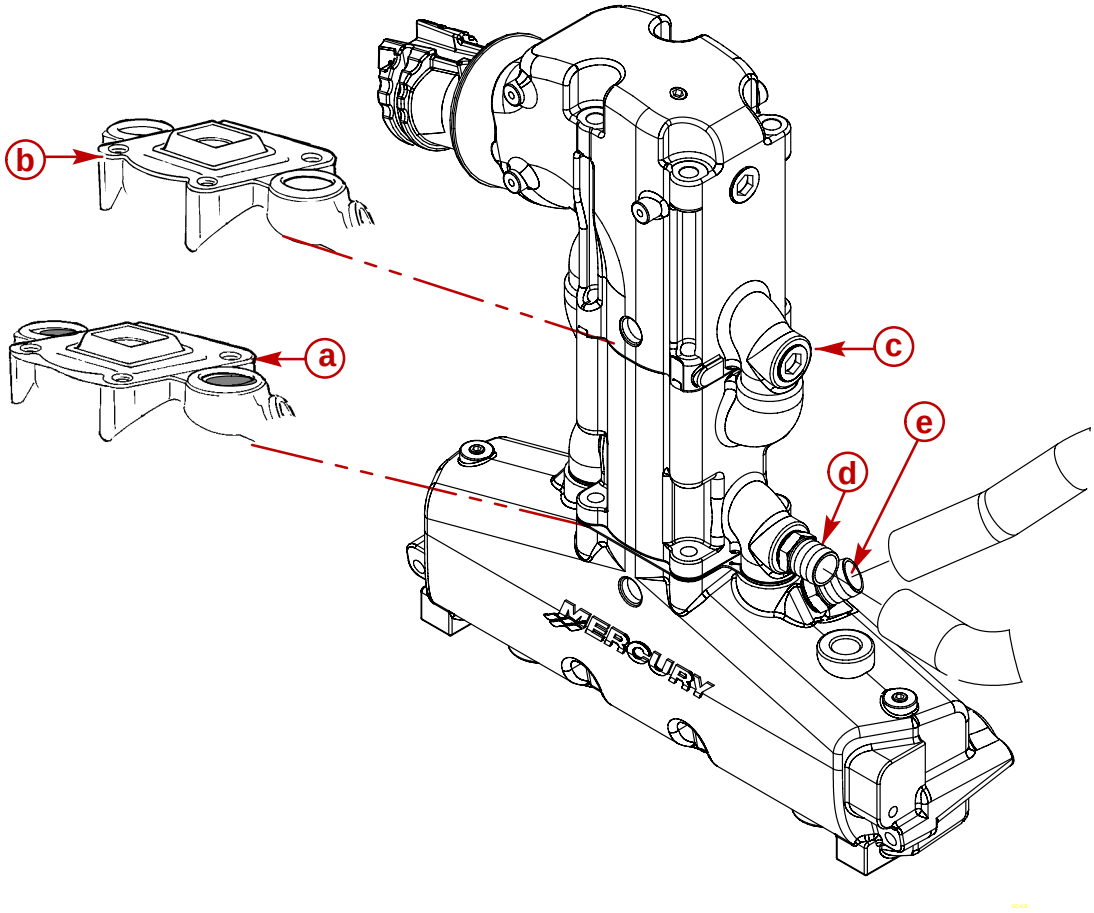


78886

MIE V-drive seawater cooled model

- **a** - Restrictor gasket positioned between exhaust manifold and riser
- **b** - Full flow gasket positioned between riser and exhaust elbow
- **c** - Restricted water port of gasket is in line with hose fitting of riser
- **d** - Exhaust elbow inlet water port with pipe plug
- **e** - Riser inlet water port with hose fitting
- **f** - Exhaust manifold outlet water port with pipe plug

11. **Closed Cooled Models:** Place the block-off gasket on the exhaust manifold with the side marked “UP” visible.

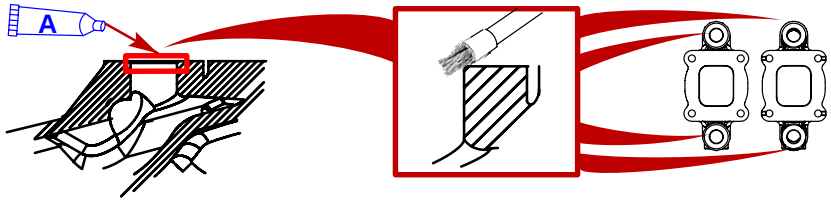


78891

MCM and MIE In-line exhaust closed cooled model

- **a** - Block-off gasket positioned between exhaust manifold and riser
- **b** - Full flow gasket positioned between riser and exhaust elbow
- **c** - Exhaust elbow inlet water port with pipe plug
- **d** - Riser inlet water port with hose fitting
- **e** - Exhaust manifold outlet water port with hose fitting

12. Apply sealant to the edge of each of the 4 water ports located on the riser.



78807

Description		Where Used	Part Number
A	Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227-1

13. Place the riser on the exhaust manifold. Refer to exploded view preceding for correct placement.

NOTE: *Position of the riser water port is placed closest to exhaust manifold.*

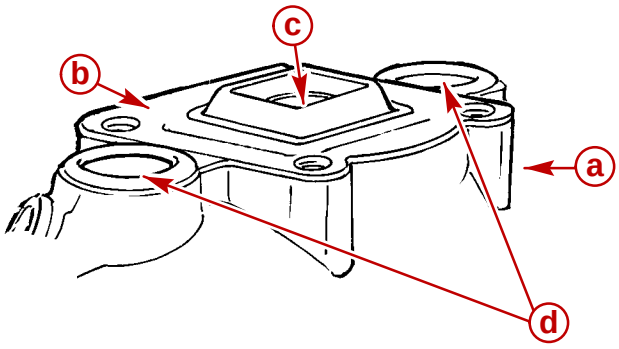
IMPORTANT: Ensure that the hose fitting located in the riser water port is positioned to accept the engine water hose.

14. **152 mm (6 inch) Riser Model:** Install and hand-tighten 4 screws, 3/8-16 x 1 in. (25 mm) long, to temporarily secure the riser and gasket to the exhaust manifold.

⚠ CAUTION

Avoid severe engine damage. The turbulator gasket MUST BE properly installed to avoid overheating due to insufficient water flow or coolant loss through exhaust.

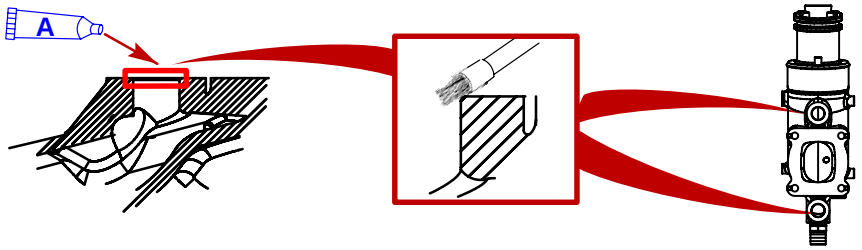
15. Place the full flow gasket on the riser with the side marked “UP” visible.



78485

a - Exhaust manifold
b - Full flow gasket
c - Turbulator oriented up
d - Passages fully open

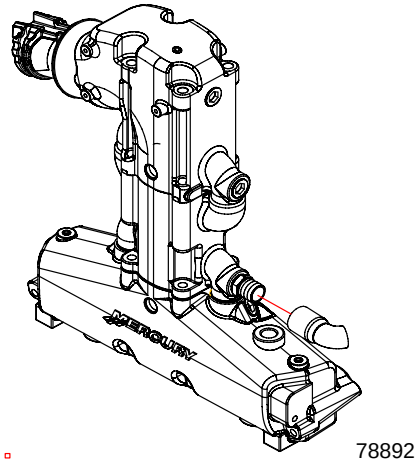
16. Apply sealant to the edge of each of the 2 water ports located on the exhaust elbow.



78807

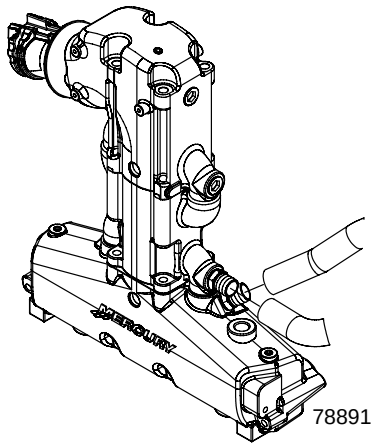
Description		Where Used	Part Number
A	Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227-1

17. Place the exhaust elbow on the riser.



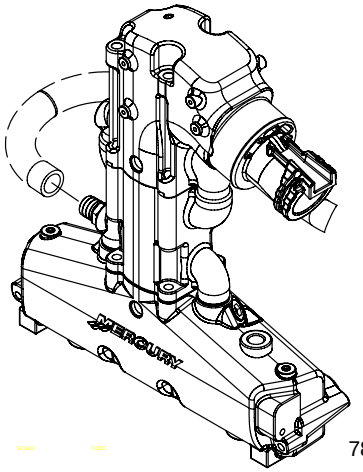
78892

Seawater cooled 152 mm (6 in.) riser



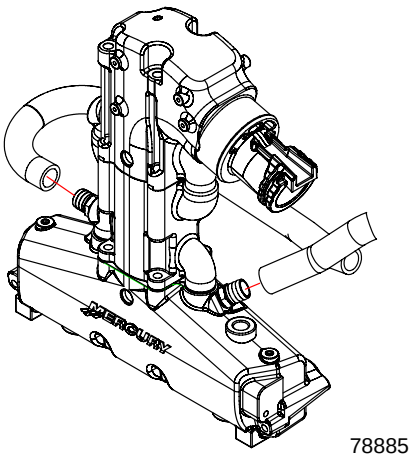
78891

Closed cooled 152 mm (6 in.) riser



78886

Seawater cooled V-drive 152 mm (6 in.) riser



78885

Closed cooled V-drive 152 mm (6 in.) riser

IMPORTANT: To ensure correct torque, the exhaust elbow screws without a flanged head require that a specific flat washer be used in conjunction with the screw. If a flange head bolt is used, no washer is needed. Refer to the *Mercury Precision Parts/Quicksilver Accessories Guide.*

18. If applicable, assemble washers to the exhaust elbow bolts.
19. Apply sealant to exhaust elbow bolt threads and hand-start to temporarily secure the assembly.

Description	Where Used	Part Number
Perfect Seal	Exhaust elbow bolt threads	92-34227-1

20. Align the exhaust elbow to the intermediate elbow or engine exhaust system.
21. **152 mm (6 inch) Riser Models:** Tighten and torque bolt holding the riser to the exhaust manifold.

NOTE: *Gasket is not reusable. Inspect for proper gasket and component position before torquing.*

Description		Nm	lb-in.	lb-ft
Exhaust elbow and riser to exhaust manifold bolt or nut				
Tighten fasteners evenly using X pattern from corner to corner	First pass	9	84	
	Final pass	61		45

22. Torque the exhaust elbow fasteners.

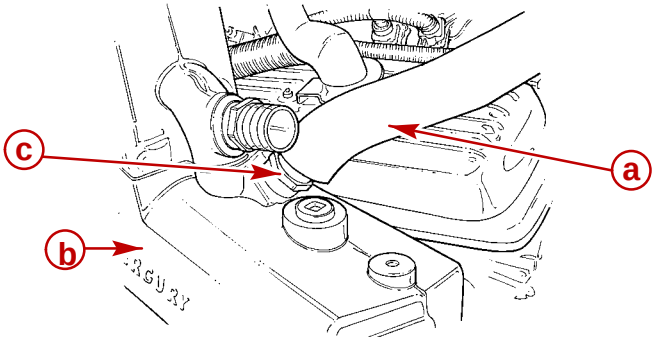
Description		Nm	lb-in.	lb-ft
Exhaust elbow and riser to exhaust manifold bolt or nut				
Tighten fasteners evenly using X pattern from corner to corner	First pass	9	84	
	Final pass	61		45

23. **Seawater Cooled Models:** Connect the engine water hoses to the hose fitting of riser and tighten hose clamps securely.

⚠ CAUTION

Avoid severe engine damage due to improper hose connection, causing coolant to discard out exhaust. Do not connect the engine coolant hose to the exhaust elbow.

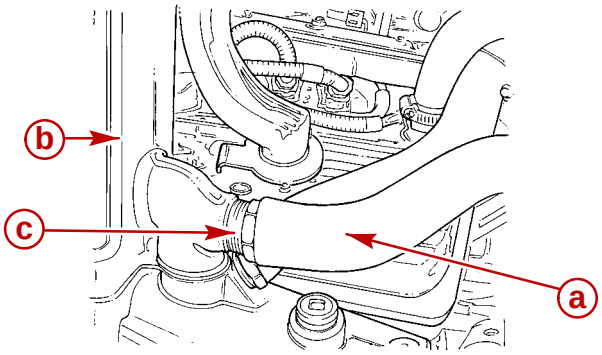
24. **Closed Cooled Models:** Connect the coolant hose from the thermostat housing to the hose fitting of the top of the exhaust manifold. Tighten hose clamps securely.



78758

a - Engine coolant hose
b - Exhaust manifold
c - Hose fitting of the exhaust manifold

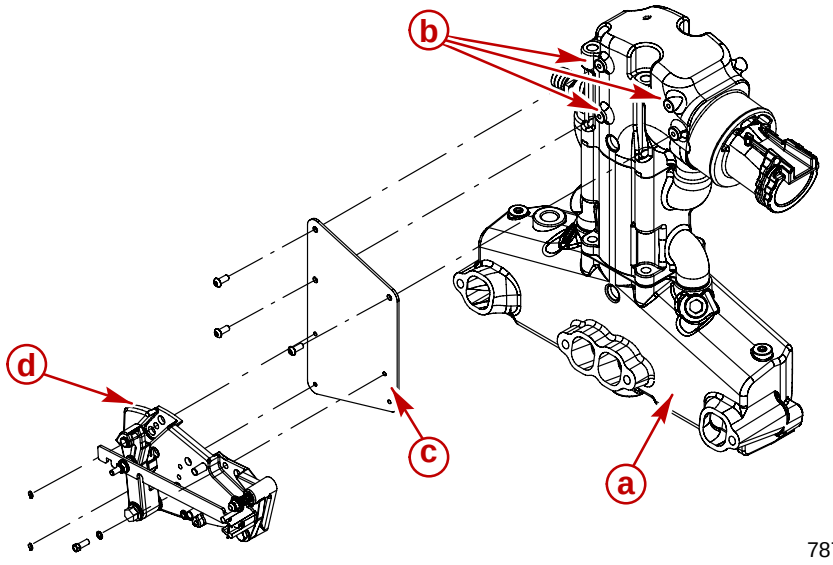
25. **Closed Cooled Models:** Connect the engine water hose from the heat exchanger to the exhaust riser and tighten hose clamps securely.



78759

a - Engine water hose
b - Exhaust elbow
c - Hose fitting of the riser

26. **MCM Models, Starboard Exhaust Elbow:**
    a. For 152 mm (6 in.) riser, install the drop-down shift plate bracket.
    b. Install the shift plate assembly to the elbow.
    c. Tighten securely.



Drop-down bracket for the 152 mm (6 in.) riser assembly

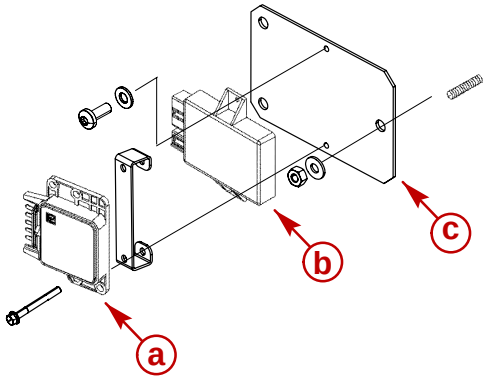
a - Exhaust manifold, riser, and elbow assembly
b - Bracket mounting holes
c - Drop-down bracket
d - Shift bracket

27. **Models With The ECM Installed To The Port Exhaust Elbow With 76 mm (3 in.) Riser:**

a. Install the ECM drop-down bracket.

b. Install the ECM bracket and the ECM to the exhaust elbow.

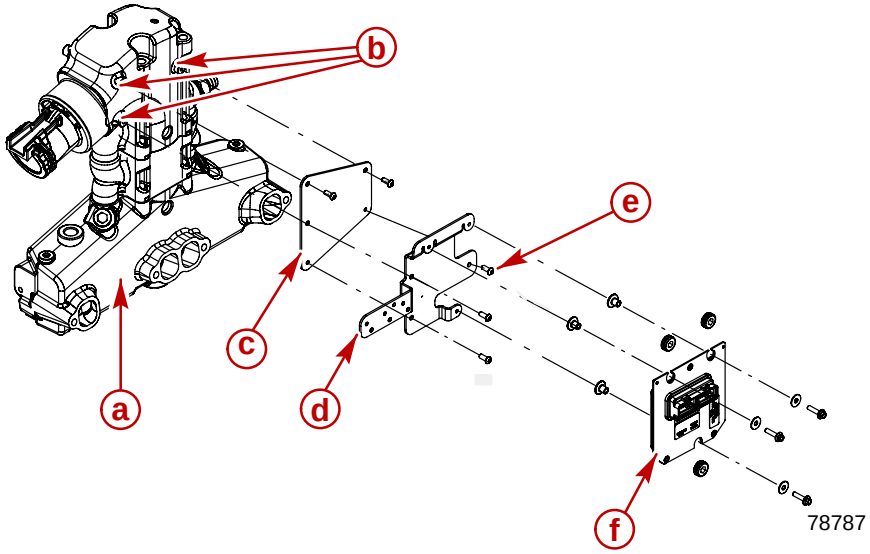
c. Tighten securely.



79370

Drop-down bracket for the 76 mm (3 in.) riser assembly for carbureted models

a - Knock module
b - Ignition module
c - Drop-down bracket

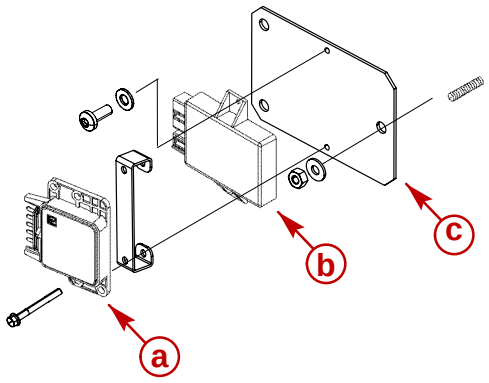


78787

Drop-down bracket for the 76 mm (3 in.) riser assembly for MPI models

a - Exhaust manifold, riser, and elbow assembly
b - Bracket mounting holes
c - Drop-down bracket
d - ECM Bracket
e - Short screw
f - ECM

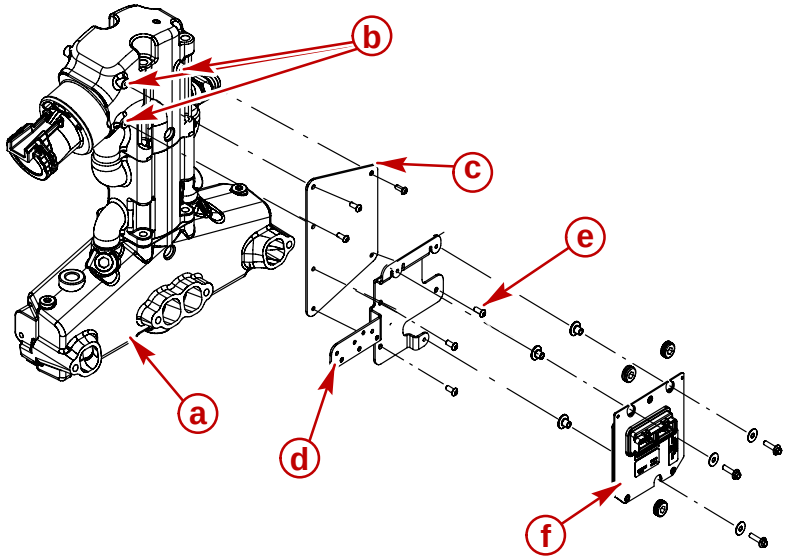
28. **Models with the ECM installed to the port exhaust elbow with 152 mm (6 in.) riser:**
    a. Install the ECM drop-down bracket.
    b. Install the ECM bracket and the ECM to the exhaust elbow.
    c. Tighten securely.



79370

Drop-down bracket for the 152 mm (6 in.) riser assembly for carbureted models

a - Knock module
b - Ignition module
c - Drop-down bracket



78789

Drop-down bracket for the 152 mm (6 in.) riser assembly for MPI models

a - Exhaust manifold, riser, and elbow assembly
b - Bracket mounting holes
c - Drop-down bracket
d - ECM bracket
e - Short screw
f - ECM

29. Secure the engine exhaust system.
30. Install any additional components removed during disassembly.
31. **Closed Cooled Models:** Refill closed cooling system to operating level.
32. Reconnect the battery cables to the battery. Tighten securely.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

33. Supply cooling water to the engine.
34. Start the engine and check for exhaust and water leaks.

NOTES:

EXHAUST SYSTEM

Section 7E - Warm Risers With Dry Joint

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7 E

Models Covered

Dry Joint Models With Warm Risers

Model	Serial Number or Year
Sterndrive (MCM) models	0M615000 and Above
Inboard and Tow Sports (MIE) models	0M390000 and Above

Lubricants / Sealants / Adhesives

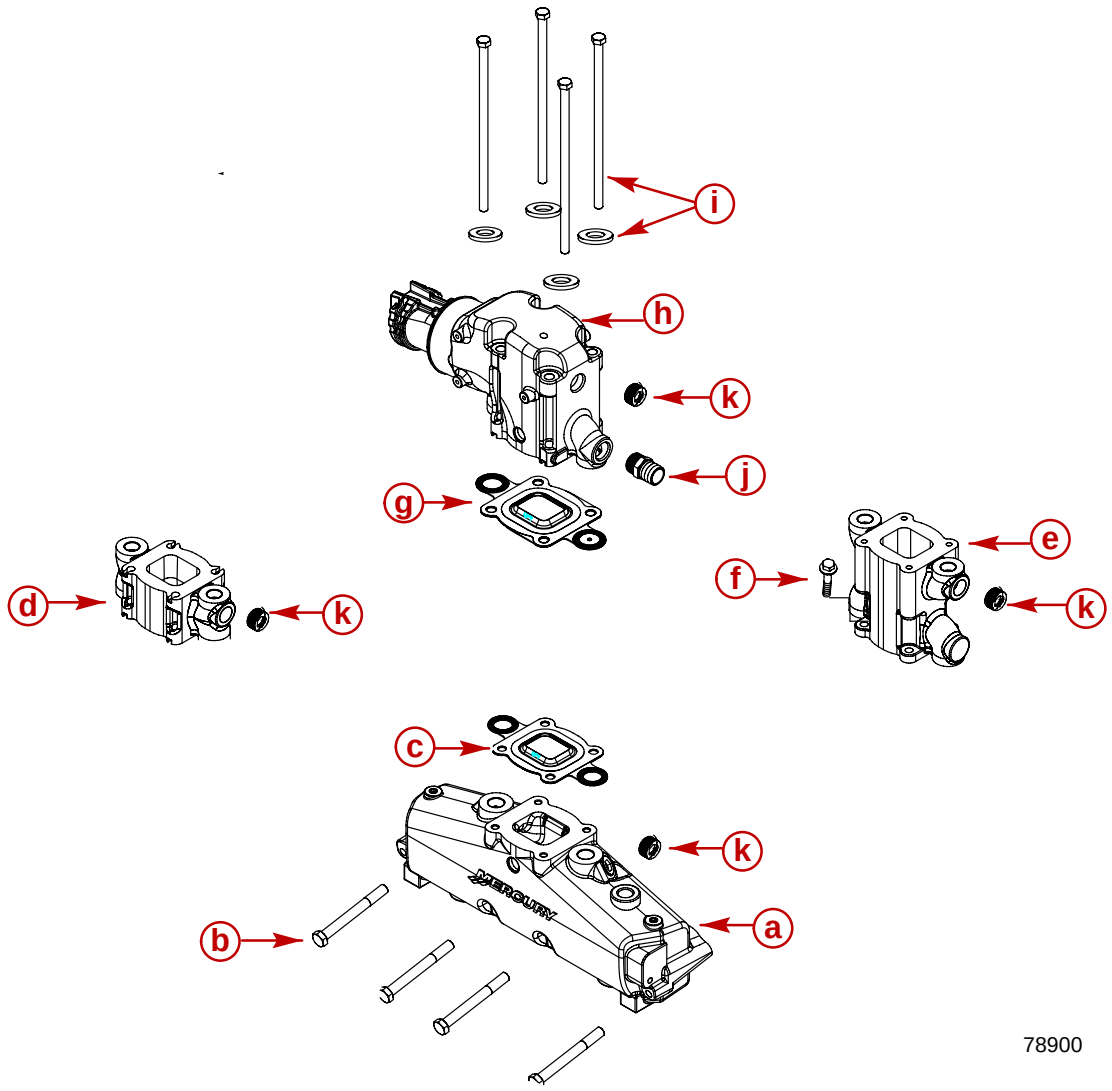
Description	Where Used	Part Number
Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227-1
	Exhaust elbow bolt threads	
Loctite 567 PST Pipe Sealant	Hose fitting	92-809822

Equivalent products may be used.

Exploded View

Seawater Cooled Models

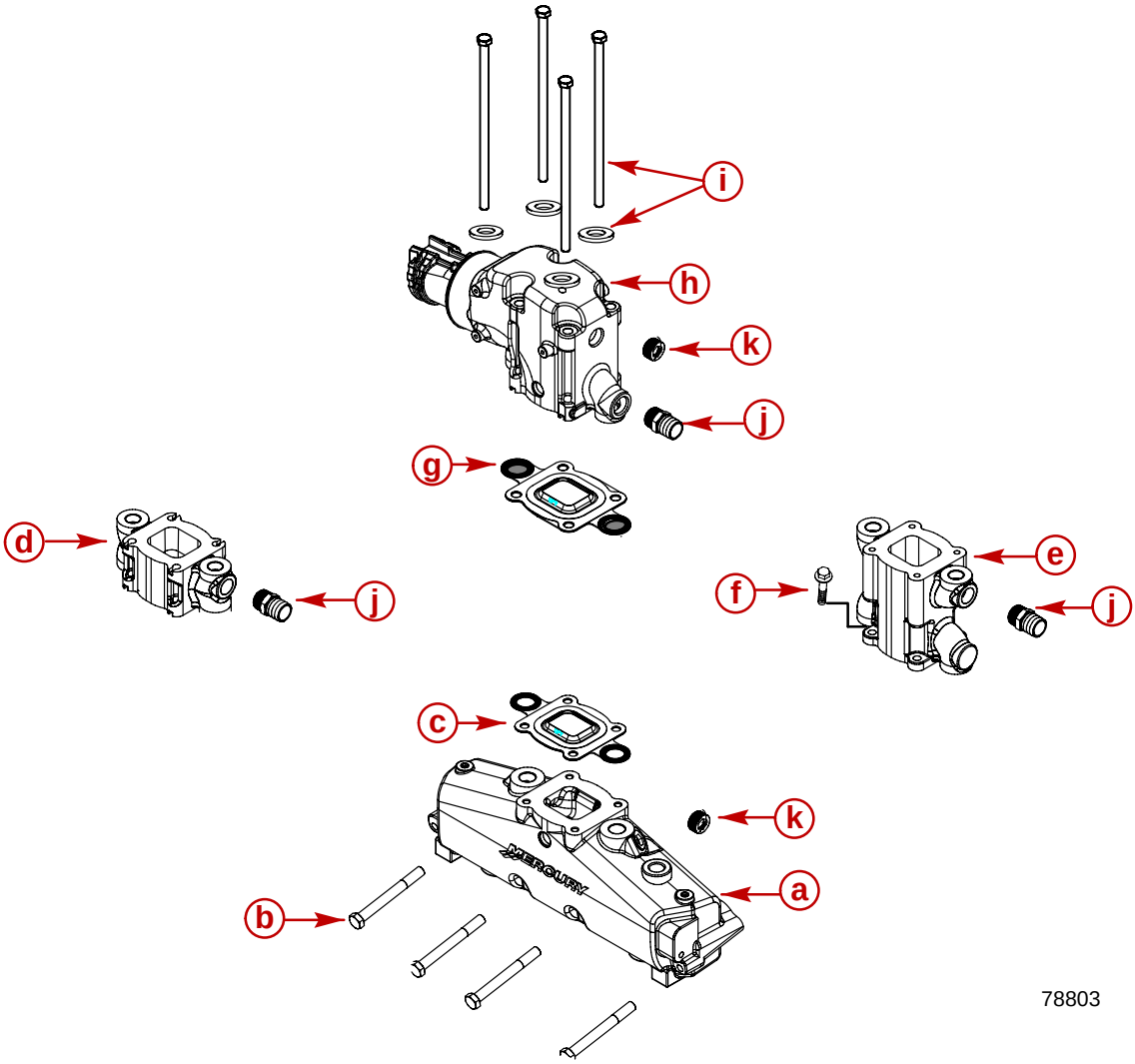
IMPORTANT: On seawater cooled models, always position the restrictor gasket with the restricted port on the same side of the exhaust manifold as the exhaust elbow or riser hose fitting.



a - Exhaust manifold
b - Manifold to cylinder head bolt (4)
c - Full flow gasket, with turbulator
d - 76 mm (3 in.) warm riser
e - 152 mm (6 in.) warm riser
f - Riser to exhaust manifold bolt (4)
g - Restrictor gasket, with turbulator (seawater cooled models)
h - Exhaust elbow
i - Exhaust elbow to riser or exhaust manifold bolt and washer (4 each)
j - Hose fitting
k - Pipe plug

NOTE: *Replacement fasteners "**i**" will be flange head bolts.*

Closed Cooled Models



a - Exhaust manifold
b - Manifold to cylinder head bolt (4)
c - Full flow gasket, with turbulator
d - 76 mm (3 in.) warm riser
e - 152 mm (6 in.) warm riser
f - Riser to exhaust manifold bolt (4)
g - Block-off gasket, with turbulator (closed cooled models)
h - Exhaust elbow
i - Exhaust elbow to riser or exhaust manifold bolt and washer (4 each)
j - Hose fitting
k - Pipe plug

NOTE: *Replacement fasteners "**i**" will be flange head bolts.*

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

Description		Nm	lb-in.	lb-ft
Exhaust elbow to riser and riser to exhaust manifold bolt or nut				
Tighten fasteners evenly using X pattern from corner to corner	First pass	9	84	
	Final pass	61		45
Exhaust manifold and exhaust elbow pipe plug		50		37
Exhaust manifold and exhaust elbow hose fitting		50		37

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire, or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables from the battery.

⚠ CAUTION

Avoid severe engine damage. Exhaust elbows and manifolds MUST BE drained to prevent coolant / water from entering combustion chambers when exhaust elbows are removed.

1. **Seawater Cooled Models:** Drain the seawater section of the engine.

1. **Closed Cooled Models:** Drain the coolant section of the engine. Refer to **Section 6C**.

2. Disconnect the engine exhaust hoses. Retain fasteners.
3. Disconnect all hoses from the exhaust manifold, riser, and exhaust elbow. Retain fasteners.
4. Remove and retain any items or components that are mounted to the exhaust manifold, riser, and the exhaust elbow of the engine.
5. Remove the exhaust elbow and riser. Retain fasteners.
6. Remove the exhaust manifold. Retain fasteners.
7. Discard used gaskets.

Cleaning And Inspection

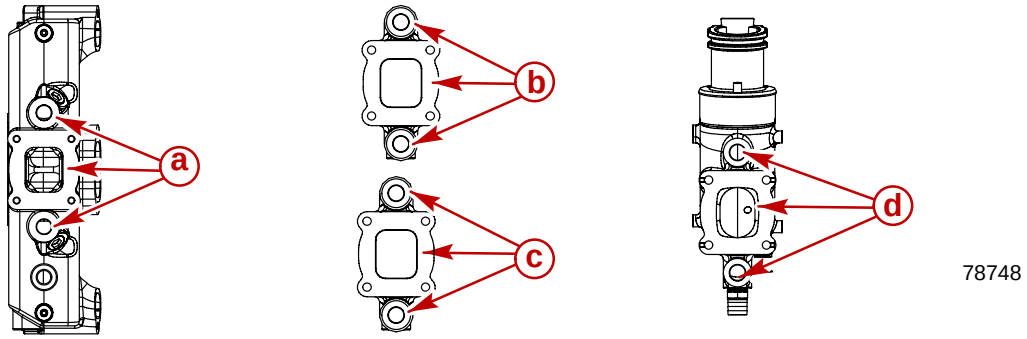
1. Clean the gasket material from all surfaces and wash the parts in solvent.
2. Inspect the water passages for foreign material. The passages must be clean for efficient cooling.

NOTE: *If more thorough inspection is desired, the pipe plugs may be removed from the exhaust manifold and the exhaust elbow.*

IMPORTANT: If the pipe plugs are removed, coat the threads with sealant before reinstalling.

Description	Where Used	Part Number
Loctite 567 PST Pipe Sealant	Pipe plug	92-809822

3. Inspect the manifold, elbow, and riser for cracks.
4. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches or water and exhaust leaks may result.
5. Inspect for damaged metal caused by saltwater or exhaust gas corrosion in the manifold, elbow, and riser.
6. Use a straightedge and feeler gauge to measure the profile flatness of all gasket surfaces on the manifold, elbow, and riser.
7. Measure the surface flatness of all gasket surfaces on the manifold, elbow, and riser.



a - Exhaust manifold gasket sealing surface
b - Riser gasket sealing surface on top side
c - Riser gasket sealing surface on bottom side
d - Exhaust elbow gasket sealing surface

NOTE: *Only use this specification if the gasket surfaces on used exhaust components have to be machined to remove minor corrosion.*

Description		mm (in.)
Surface Flatness	Maximum overall difference	0.07 (0.003)

NOTE: *The maximum material that can be removed is 0.25 mm (0.010 in.). When torquing the attaching bolts, ensure that they are not contacting the bottom of the threaded hole in the manifold.*

8. Replace all damaged components.

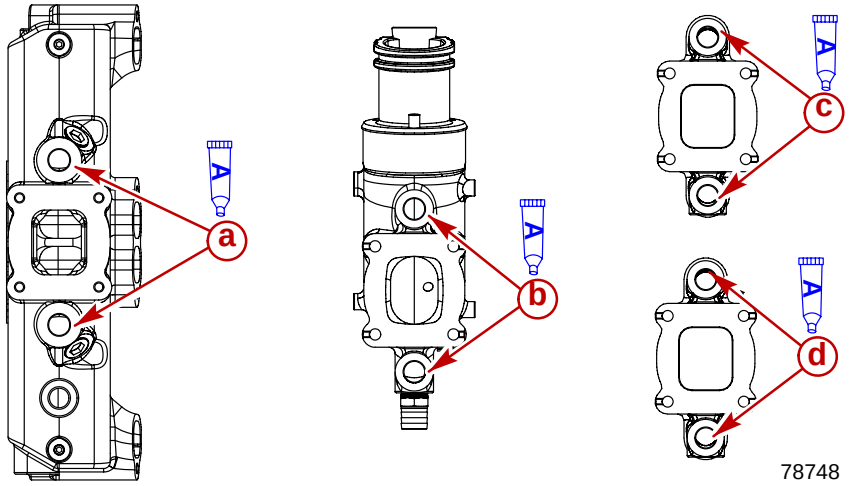
Reassembly

IMPORTANT: The edge of the water ports on all cast iron parts must be coated with Perfect Seal during assembly.

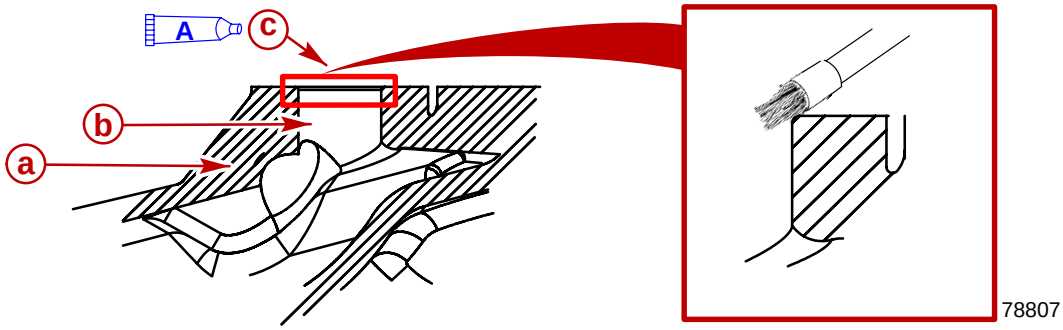
IMPORTANT: If bare metal is present on the gasket sealing surface, Perfect Seal should be applied to that area before assembly.

Description	Where Used	Part Number
Perfect Seal	Bare metal gasket sealing surface	92-34227-1

1. If exhaust elbow assembly is disassembled or risers are added, apply sealant to edge of all water ports (exhaust manifold, both sides of the riser, and exhaust elbow).



a - Exhaust manifold water port sealing surface
b - Exhaust elbow water port sealing surface
c - Riser water port sealing surface on top side
d - Riser water port sealing surface on bottom side



a - Exhaust manifold (cross section)
b - Exhaust manifold water port
c - Edge of water port (area to apply sealant)

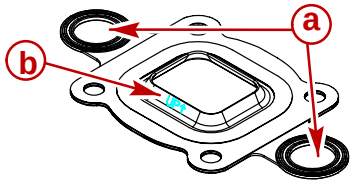
Description		Where Used	Part Number
A	Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227-1

Gasket Application

Full Flow Gasket

Model	Description
Engines with risers	Full flow gasket

IMPORTANT: On warm riser models, the full flow gasket must be placed between exhaust manifolds and riser.



78804

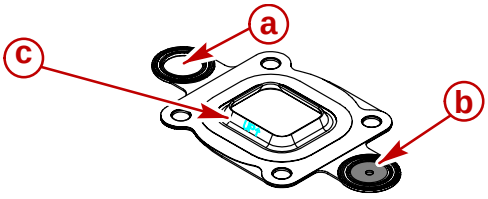
a - Passages fully open
b - Turbulator oriented up

Restrictor Flow Gasket

Model	Description
Seawater cooled	Restrictor gasket

IMPORTANT: On warm riser models, the restrictor gasket must be placed between the riser and the exhaust elbow.

IMPORTANT: The restrictor end of the gasket must be positioned to the seawater inlet side of the exhaust elbow.



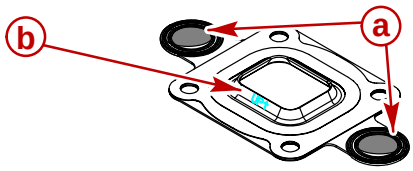
78805

a - Full flow passage
b - Restricted flow passage
c - Turbulator oriented up

Block-Off Gasket

Model	Description
Closed cooled	Block-off gasket

IMPORTANT: On warm riser models, the block-off gasket must be placed between the riser and the exhaust elbow.



78806

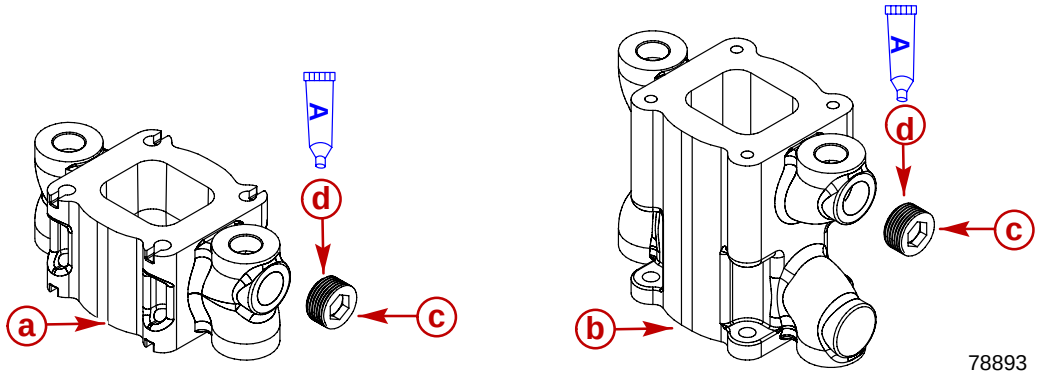
a - No opening for water flow
b - Turbulator oriented up

Installation

⚠ CAUTION

Avoid severe engine damage. The turbulator gasket MUST BE properly installed to avoid overheating due to insufficient water flow or coolant loss through exhaust.

1. **Seawater Cooled Models:** Apply sealant to threads of the pipe plug and install into the riser.



78893

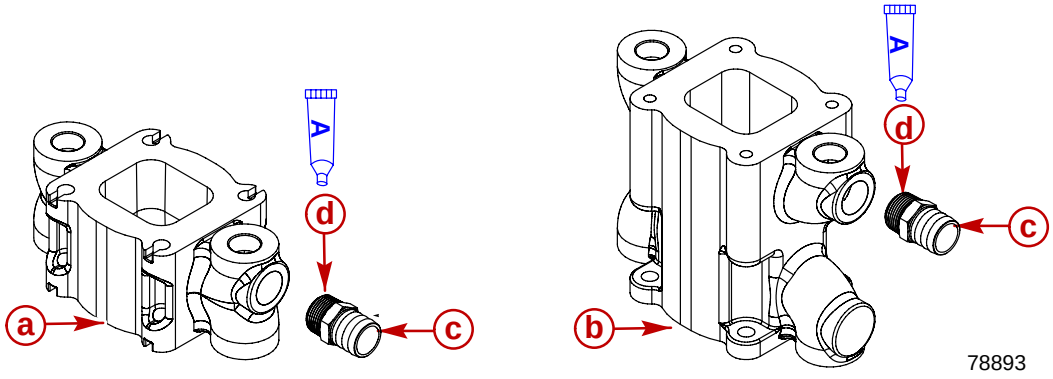
a - 76 mm (3 in.) riser
b - 152 mm (6 in.) riser
c - Pipe plug
d - Sealant applied to threads

Description		Where Used	Part Number
A	Loctite 567 PST Pipe Sealant	Pipe plug	92-809822

2. Torque pipe plug.

Description	Nm	lb-in.	lb-ft
Pipe plug to riser	50		37

3. **Closed Cooled Models:** Apply sealant to threads of the hose fittings and install into the risers.



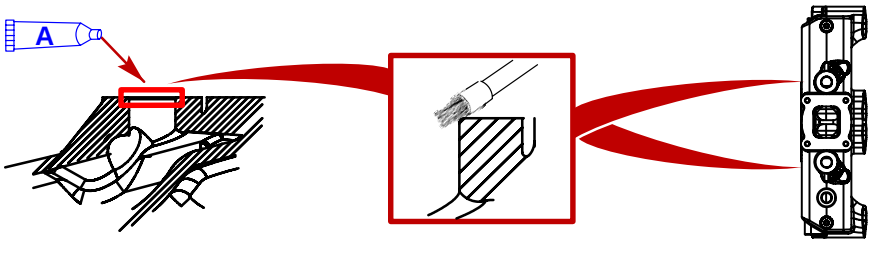
a - 76 mm (3 in.) riser
b - 152 mm (6 in.) riser
c - Hose fitting
d - Sealant applied to threads

Description		Where Used	Part Number
A	Loctite 567 PST Pipe Sealant	Hose fitting	92-809822

4. Torque hose fitting.

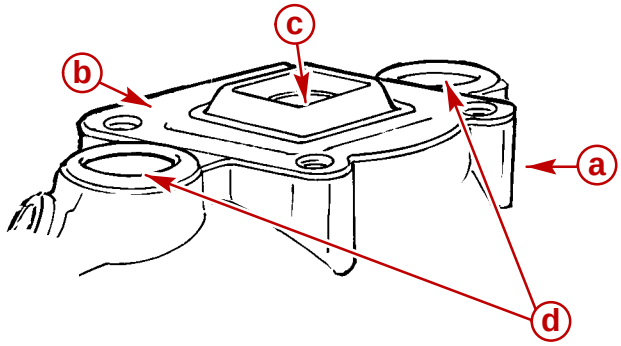
Description	Nm	lb-in.	lb-ft
Hose fitting to riser	50		37

5. Apply sealant to the edge of each of the 2 water ports located on the exhaust manifold.



Description		Where Used	Part Number
A	Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227-1

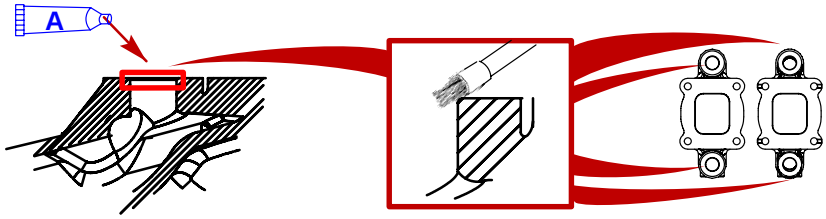
6. Place the full flow gasket on the exhaust manifold with the side marked “UP” visible.



78485

a - Exhaust manifold
b - Full flow gasket
c - Turbulator oriented up
d - Passages fully open

7. Apply sealant to the edge of each of the 4 water ports located on the riser.

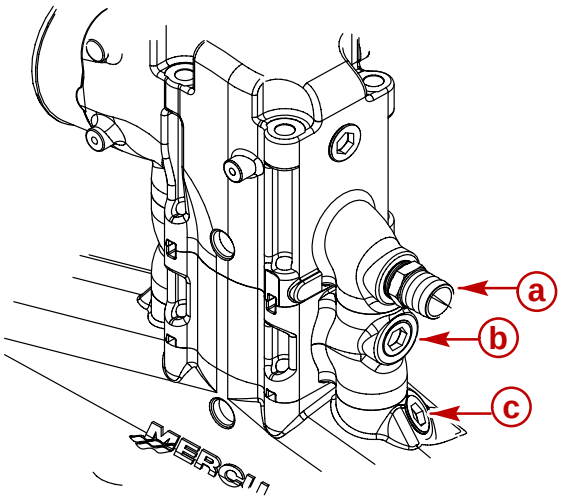


78807

Description		Where Used	Part Number
A	Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227-1

NOTE: *Position of the riser outlet water port is closest to exhaust elbow.*

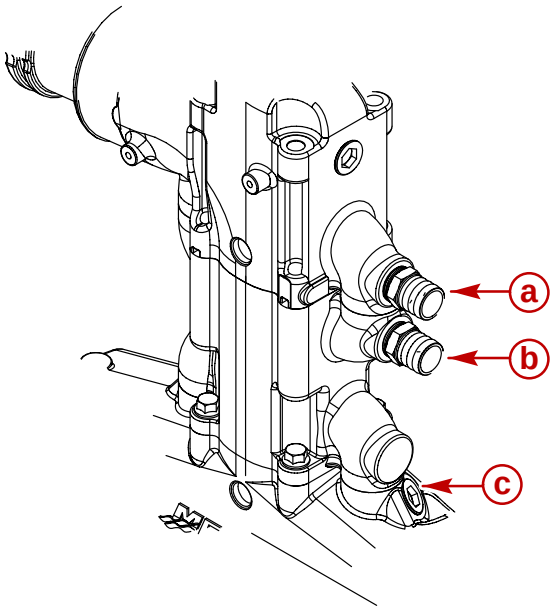
8. Place the riser on the exhaust manifold as shown.



78893

Seawater cooled models (76 mm [3 in.] riser shown, 152 mm [6 inch] riser similar)

a - Exhaust elbow inlet water port with hose fitting
b - Riser outlet water port with pipe plug (seawater cooled)
c - Exhaust manifold outlet water port with pipe plug



78893

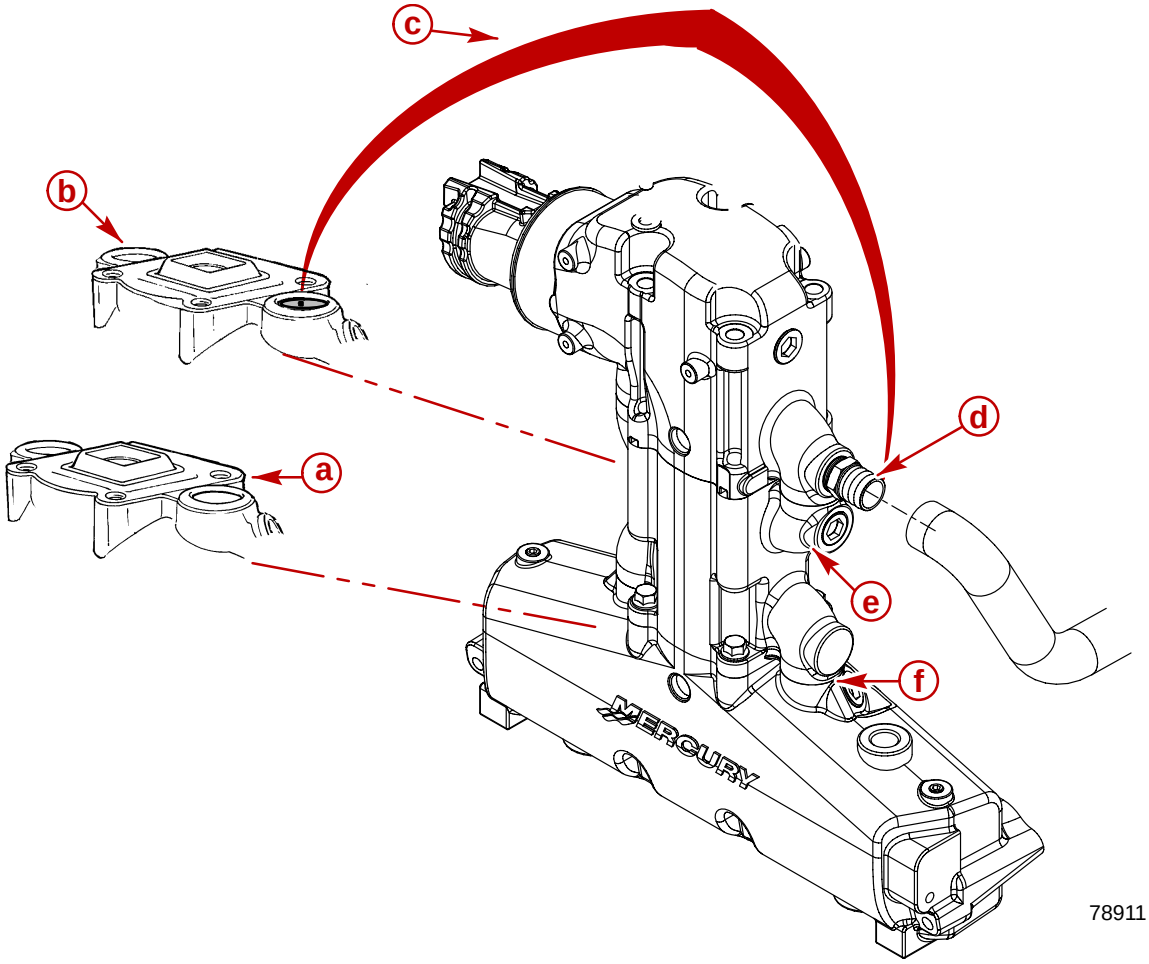
Closed cooled models (152 mm [6 in.] riser shown, 76 mm [3 in.] riser similar)

a - Exhaust elbow inlet water port with hose fitting
b - Riser outlet water port with hose fitting (closed cooled)
c - Exhaust manifold outlet water port with pipe plug

NOTE: Closed Cooled Models: *Ensure that the hose fitting located in the riser outlet water port is positioned to accept the engine coolant hose.*

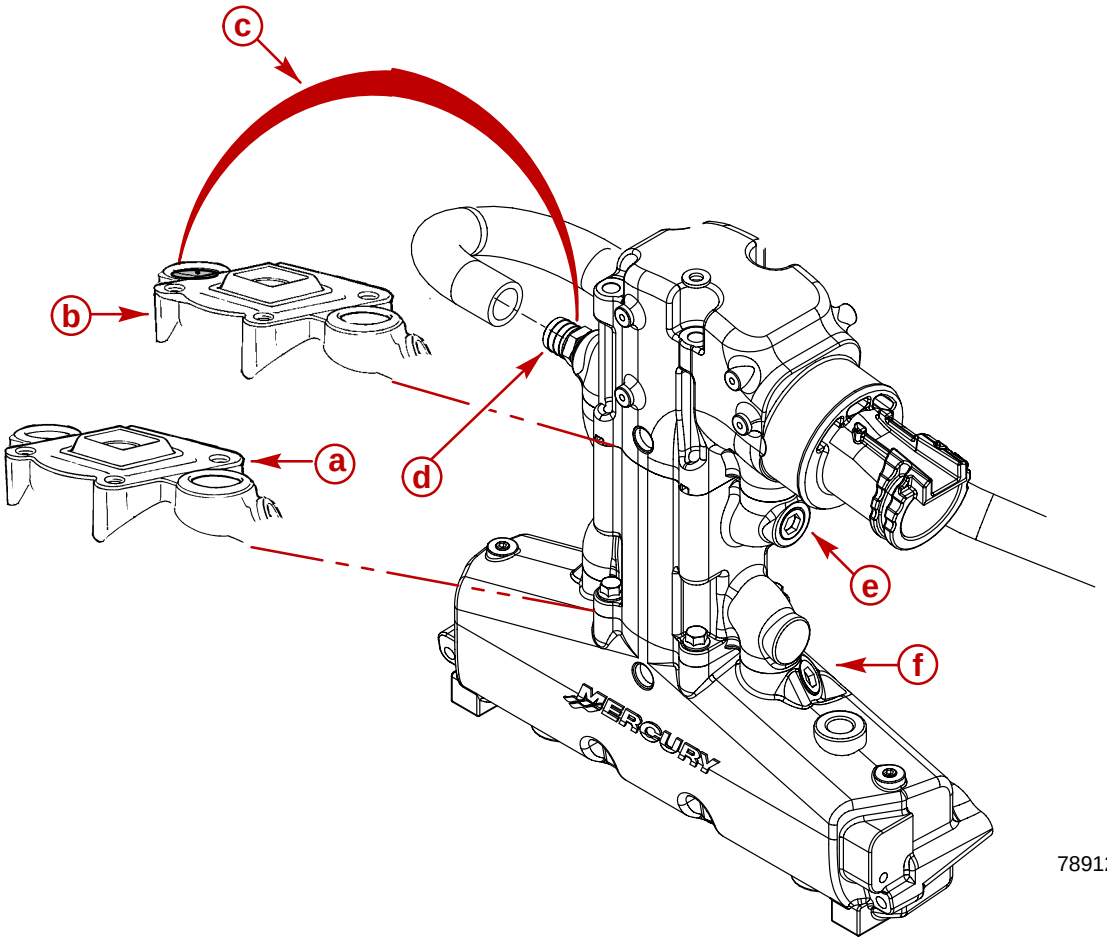
9. **152 mm (6 inch) Riser Models:** Install and hand-tighten screws to temporarily secure the riser and gasket to the exhaust manifold.

10. **Seawater Cooled Models:** Place the restrictor gasket on the riser with the side marked “UP” visible. Ensure that the restricted water port of the restrictor gasket is on the same side as the water hose fitting of the exhaust elbow.



MCM and MIE In-line exhaust seawater cooled models

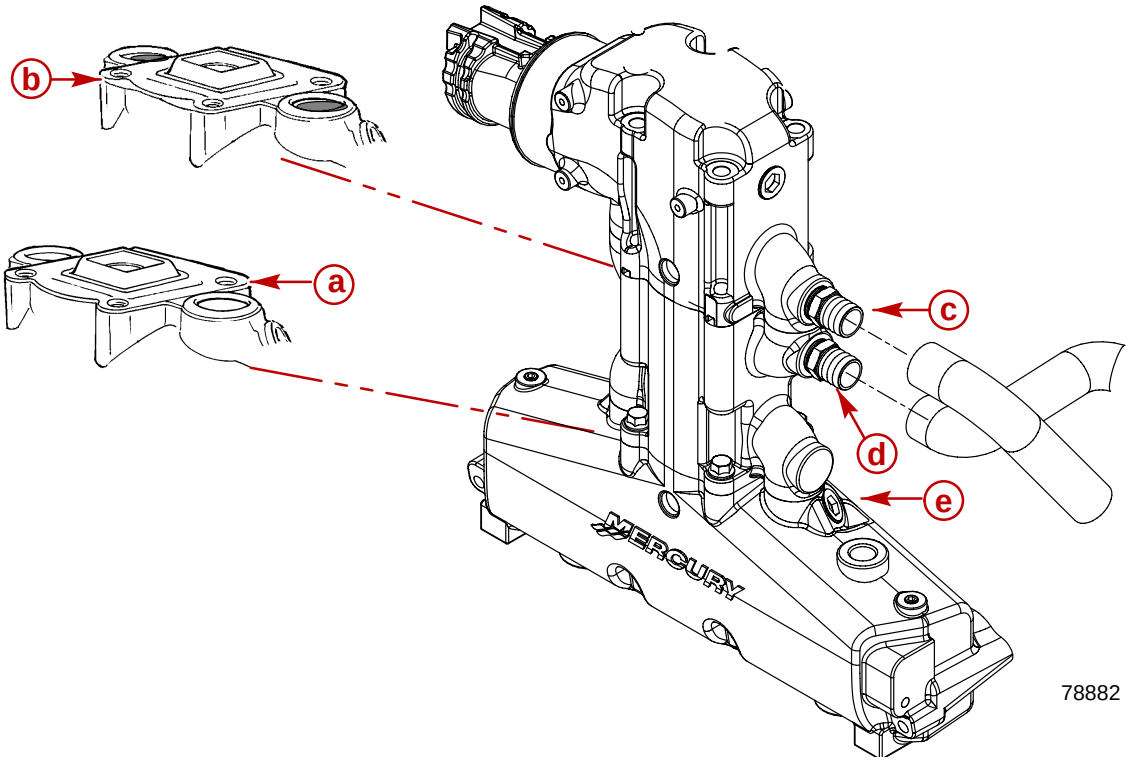
- **a** - Full flow gasket positioned between exhaust manifold and riser
- **b** - Restrictor gasket positioned between riser and exhaust elbow
- **c** - Restricted water port of gasket is in line with hose fitting of exhaust elbow
- **d** - Exhaust elbow inlet water port with hose fitting
- **e** - Riser outlet water port with pipe plug
- **f** - Exhaust manifold outlet water port with pipe plug



MIE V-drive seawater cooled models

- **a** - Full flow gasket positioned between exhaust manifold and riser
- **b** - Restrictor gasket positioned between riser and exhaust elbow
- **c** - Restricted water port of gasket is in line with hose fitting of exhaust elbow
- **d** - Exhaust elbow inlet water port with hose fitting
- **e** - Riser outlet water port with pipe plug
- **f** - Exhaust manifold outlet water port with pipe plug

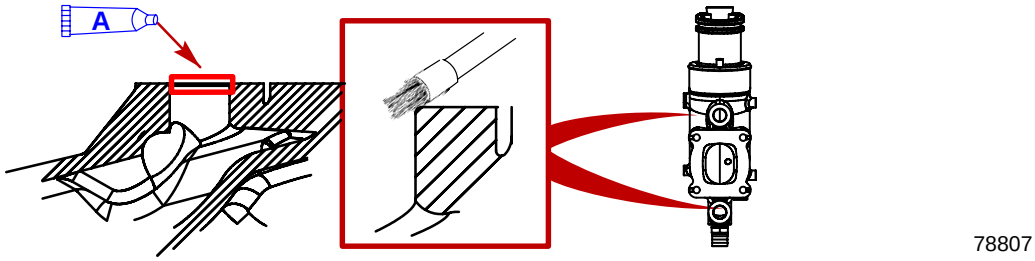
11. **Closed Cooled Models:** Place the block-off gasket on the riser with the side marked "UP" visible.



MCM and MIE In-line exhaust closed cooled models

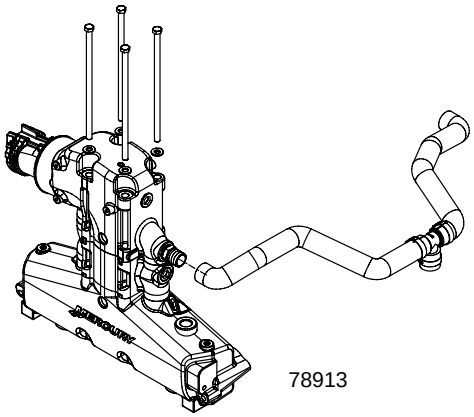
- **a** - Full flow gasket positioned between exhaust manifold and riser
- **b** - Block-off gasket positioned between riser and exhaust elbow
- **c** - Exhaust elbow inlet water port with hose fitting
- **d** - Riser outlet water port with hose fitting
- **e** - Exhaust manifold outlet water port with pipe plug

12. Apply sealant to the edge of each of the 2 water ports located on the exhaust elbow.

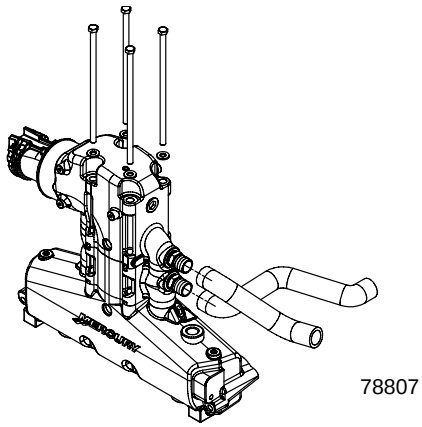


Description		Where Used	Part Number
A	Perfect Seal	Edge of water ports on the exhaust manifold, riser, and exhaust elbow	92-34227-1

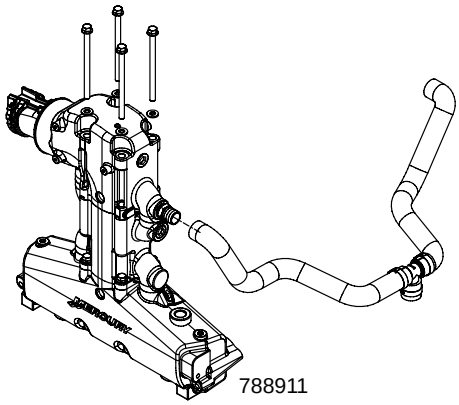
13. Place the exhaust elbow on the riser.



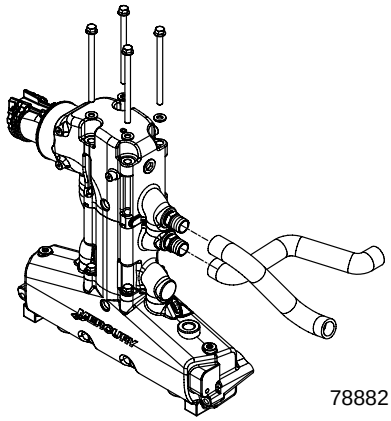
Seawater cooled 76 mm (3in.) riser



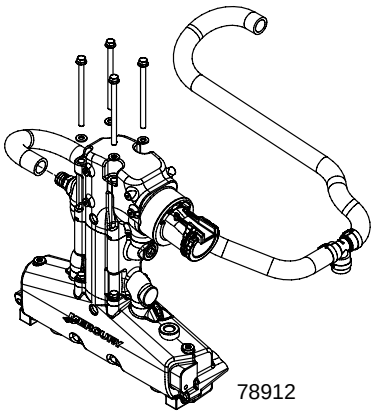
Closed cooled 76 mm (3 in.) riser



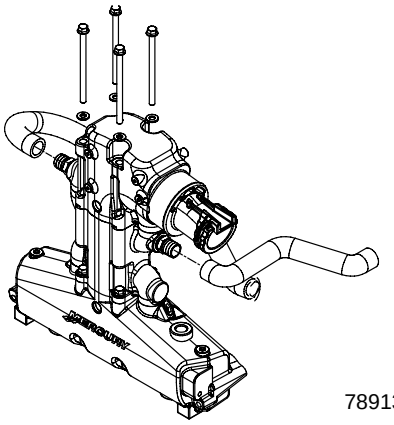
Seawater cooled 152 mm (6 in.) riser



Closed cooled 152 mm (6 in.) riser



Seawater cooled V-drive 152 mm (6 in.) riser



Closed cooled V-drive 152 mm (6 in.) riser

IMPORTANT: To ensure correct torque, the exhaust elbow screws without a flanged head require that a specific flat washer be used in conjunction with the screw. If a flange head bolt is used, no washer is needed. Refer to the *Mercury Precision Parts/Quicksilver Accessories Guide.*

14. If applicable, assemble washers to the exhaust elbow bolts.
15. Apply sealant to exhaust elbow bolt threads and hand-start to temporarily secure the assembly.

Description	Where Used	Part Number
Perfect Seal	Exhaust elbow bolt threads	92-34227-1

16. Align the exhaust elbow to the engine exhaust system.
17. **152 mm (6 in.) Riser Models:** Tighten and torque the bolt holding the riser to the exhaust manifold.

NOTE: *Gasket is not reusable. Inspect for proper gasket and component position before torquing.*

Description		Nm	lb-in.	lb-ft
Exhaust elbow and riser to exhaust manifold bolt or nut				
Tighten fasteners evenly using X pattern from corner to corner	First pass	9	84	
	Final pass	61		45

18. If applicable, ensure that washers are in place between bolt and exhaust elbow.
19. Torque the exhaust elbow fasteners.

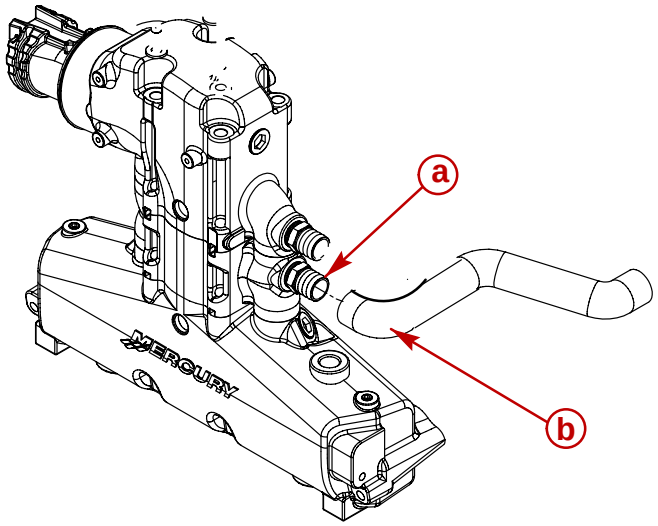
Description		Nm	lb-in.	lb-ft
Exhaust elbow and riser to exhaust manifold bolt or nut				
Tighten fasteners evenly using X pattern from corner to corner	First pass	9	84	
	Final pass	61		45

20. **Seawater Cooled Models:** Connect the engine water hoses to the exhaust elbows and tighten hose clamps securely.

⚠ CAUTION

Avoid severe engine damage due to improper hose connection, causing coolant to discard out exhaust. Do not connect the engine coolant hose to the exhaust elbow.

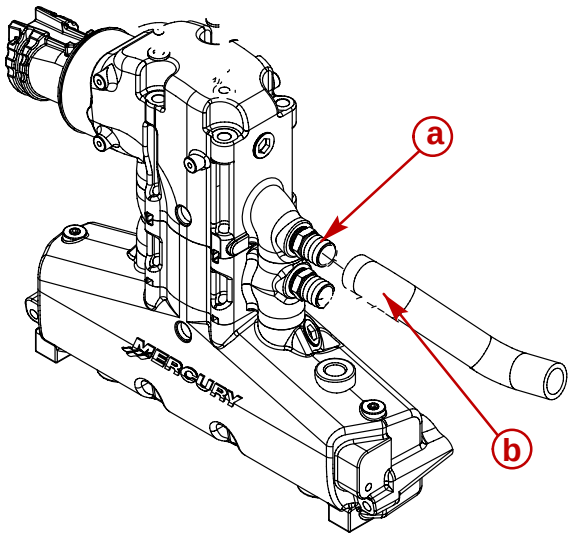
21. **Closed Cooled Models:** Connect the coolant hose from the thermostat housing to the hose fitting of the riser. Tighten hose clamps securely.



78758

a - Riser fitting
b - Engine coolant hose

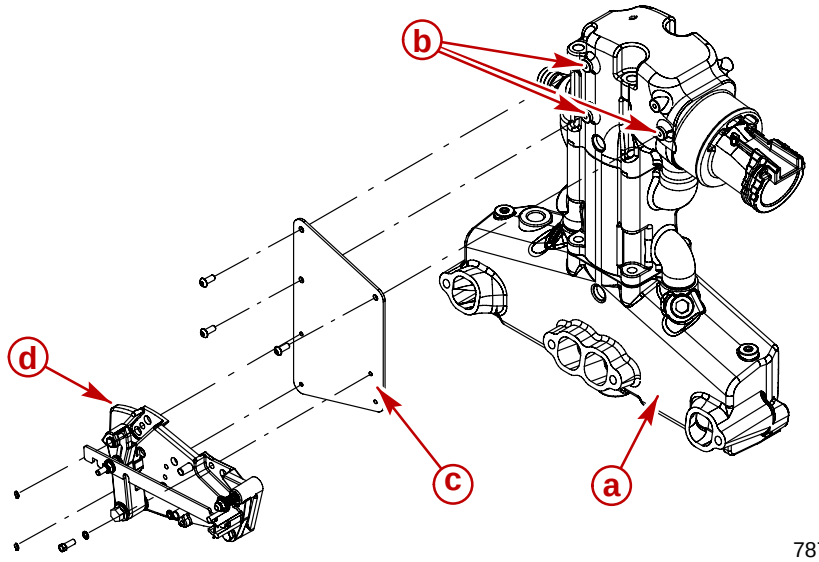
22. **Closed Cooled Models:** Connect the engine water hose from the heat exchanger to the exhaust elbow and tighten hose clamps securely.



78759

a - Exhaust elbow fitting
b - Engine water hose

23. **MCM Models, Starboard Exhaust Elbow:**
    a. For 152 mm (6 in.) riser, install the drop-down shift plate bracket.
    b. Install the shift plate assembly to the elbow.
    c. Tighten securely.

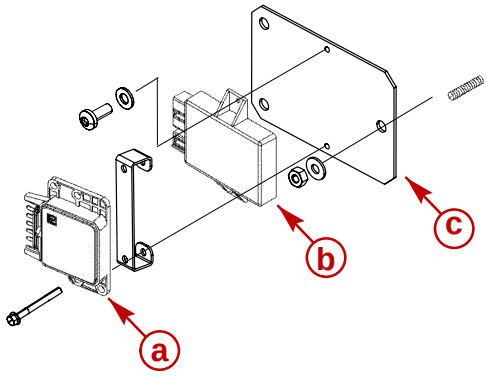


78788

Drop-down bracket for the 152 mm (6 in.) riser assembly

a - Exhaust manifold, riser, and elbow assembly
b - Bracket mounting holes
c - Drop-down bracket
d - Shift bracket

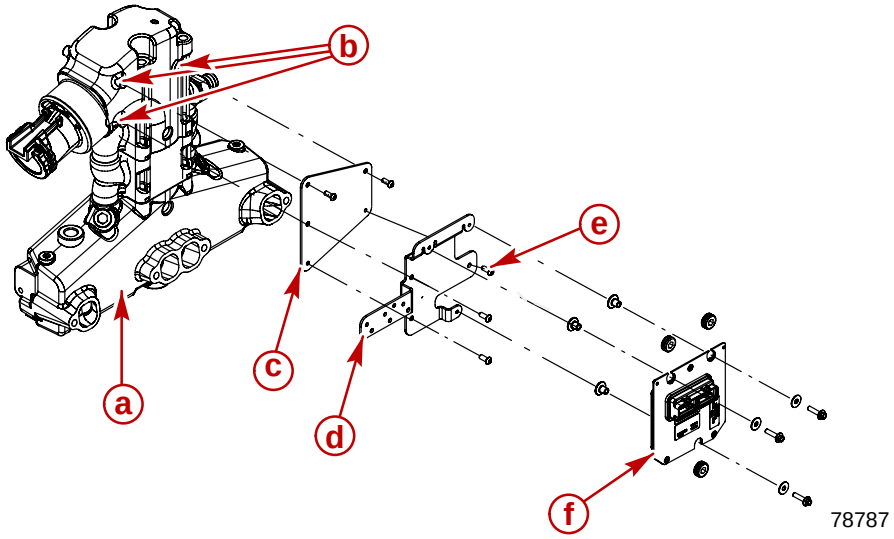
24. **All Models, Port Exhaust Elbow With 76 mm (3 in.) Riser:**
    a. Install the ECM drop-down bracket.
    b. Install the ECM bracket and the ECM to the exhaust elbow.
    c. Tighten securely.



79370

Drop-down bracket for the 76 mm (3 in.) riser assembly for carbureted models

a - Knock module
b - Ignition module
c - Drop-down bracket

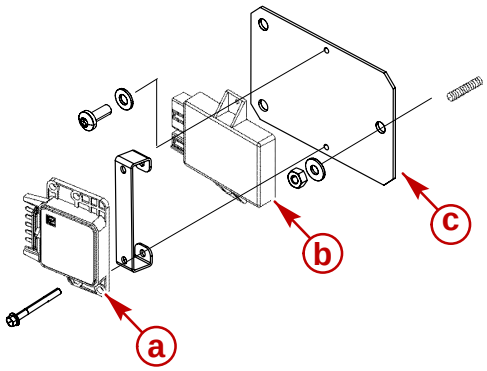


78787

Drop-down bracket for the 76 mm (3 in.) riser assembly for MPI models

a - Exhaust manifold, riser, and elbow assembly
b - Bracket mounting holes
c - Drop-down bracket
d - ECM bracket
e - Short screw
f - ECM

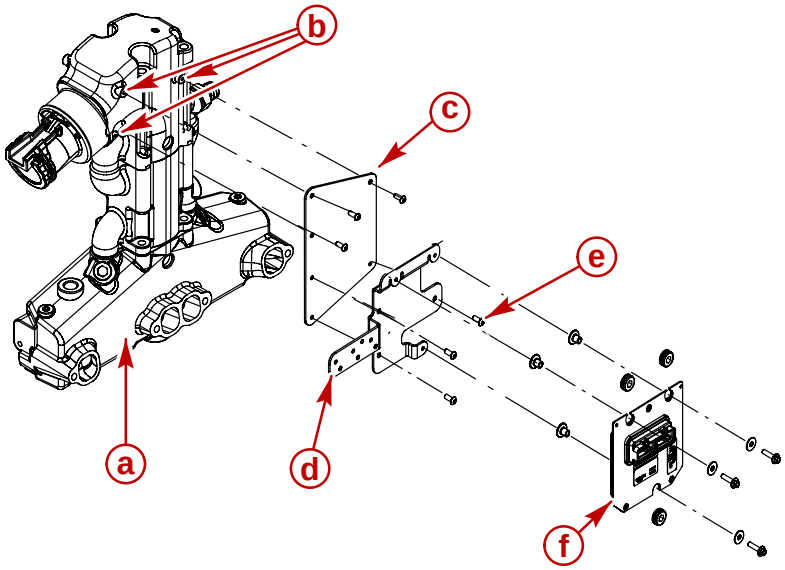
25. **All Models, Port Exhaust Elbow With 152 mm (6 in.) Riser:**
    a. Install the ECM drop-down bracket.
    b. Install the ECM bracket and the ECM to the exhaust elbow.
    c. Tighten securely.



79370

Drop-down bracket for the 152 mm (6 in.) riser assembly for carbureted models

a - Knock module
b - Ignition module
c - Drop-down bracket



78789

Drop-down bracket for the 152 mm (6 in.) riser assembly for MPI models

a - Exhaust manifold, riser, and elbow assembly
b - Bracket mounting holes
c - Drop-down bracket
d - ECM bracket
e - Short screw
f - ECM

26. Install the exhaust hoses and the cooling hoses.
27. Tighten hose clamps securely.
28. Install any additional components removed during disassembly.
29. Reconnect the battery cables to the battery. Tighten securely.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

30. Supply cooling water to the engine.
31. Start the engine and check for exhaust and water leaks.

EXHAUST SYSTEM

Section 7F - Collectors

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7F

Lubricants / Sealants / Adhesives

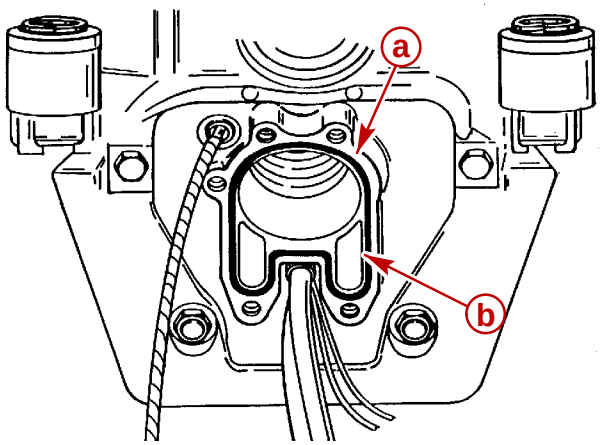
Description	Where Used	Part Number
2-4-C With Teflon	Air cylinder to silencer pipe flapper at clevis and pin	92-802859A1
Bellows Adhesive	Air pump intake filter	92-86166Q1
	Exhaust muffler O-ring seal	

Equivalent products may be used.

Important Information

To replace any component in this section of the exhaust system, the following must be adhered to:

- All mating surfaces must be clean.
- The O-ring must remain in the groove to properly seal the joints to prevent leak.
- Tighten all clamps securely.

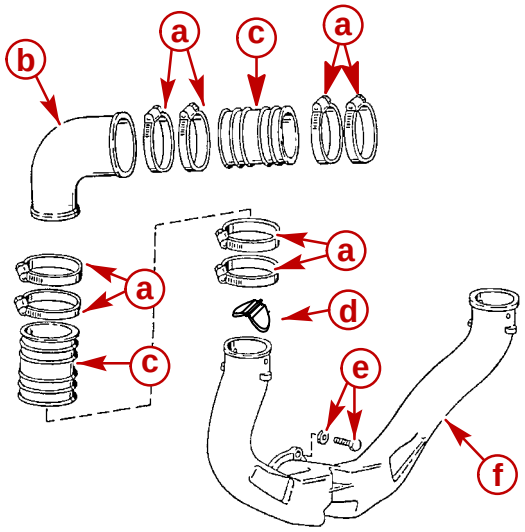


72736

Early transom model shown

a - Mating surface
b - O-ring

IMPORTANT: Each exhaust hose connection must be double clamped at each connection. Tighten hose clamps securely.



72737

a - Clamps
b - Exhaust pipe elbow
c - Exhaust hose
d - Water shutters
e - Bolts and lockwashers
f - Exhaust pipe

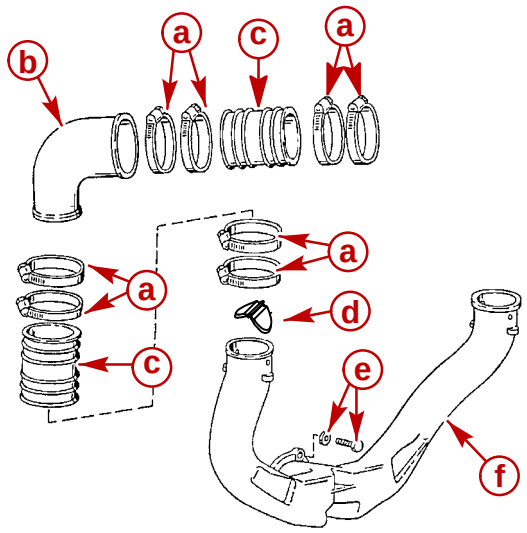
Exhaust Y-Pipe

Water Shutter

REMOVAL

IMPORTANT: The engine does not have to be removed to change the shutters.

1. Loosen the hose clamps.
2. Remove the exhaust elbow and exhaust hose.
3. Remove and discard the old water shutter.

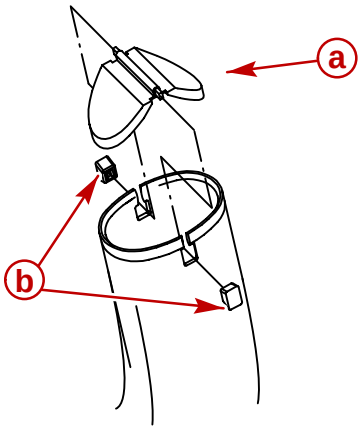


72737

a - Clamps
b - Exhaust pipe elbow
c - Exhaust hose
d - Water shutters
e - Bolts and lockwashers
f - Exhaust pipe

INSTALLATION

1. Install the new water shutter and ensure that the shutter is seated in the rubber grommets.



75760

a - Water shutter
b - Rubber grommets

IMPORTANT: Each exhaust hose connection must be double clamped at each connection. Tighten hose clamps securely.

2. Secure with 2 hose clamps at each connection.
3. Tighten hose clamps securely.

⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

4. Provide sufficient water supply to water inlet holes.
5. Start the engine and check for exhaust and water leaks.

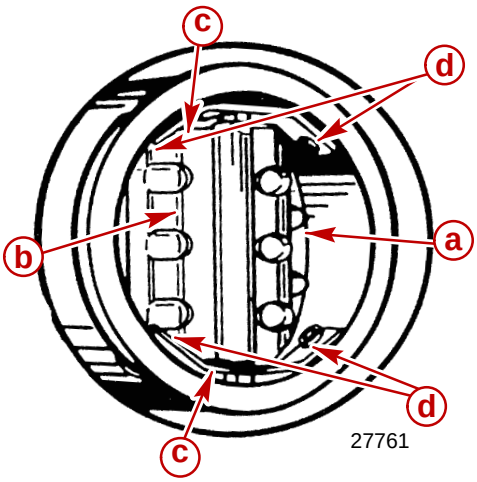
Through The Transom Exhaust

Water Shutter

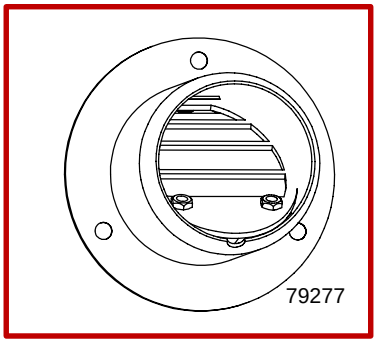
REMOVAL

IMPORTANT: The engine does not have to be removed to change the shutters.

1. Remove the exhaust hose clamps and the exhaust hose.
2. Chisel the rivets away from both support members.



Early model



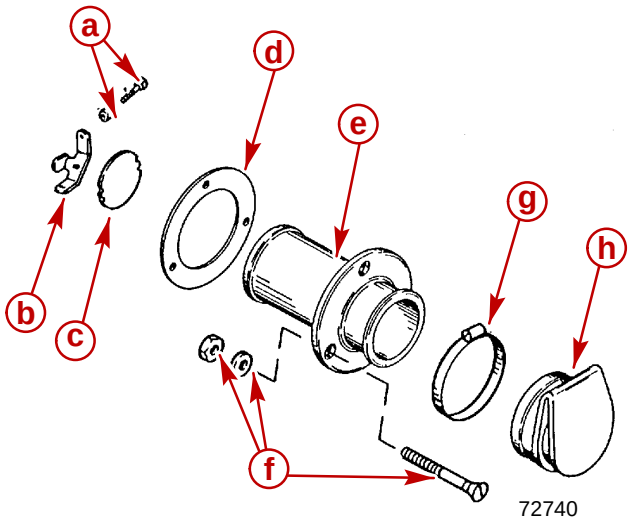
Later model

a - Shutter hinge
b - Water shutter
c - Support member
d - Rivets (4)

3. Remove and discard the old water shutter.

INSTALLATION

1. Using screws and nuts, install the support members. Ensure that the water shutter hinge will be vertical.



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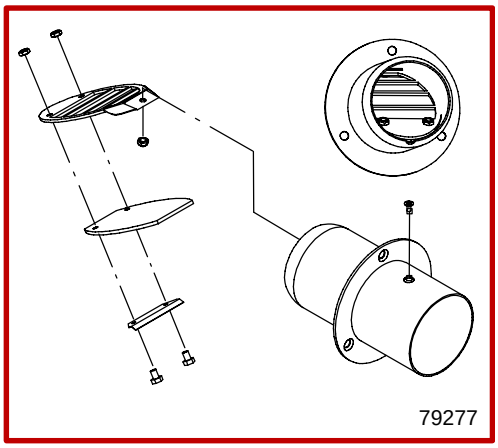

79277

Through the Transom exhaust kit

Early model (12648A2)

- **a** - Screw and nut (4)
- **b** - Support member
- **c** - Water shutter
- **d** - Gasket

Later model (843426A1)

- **e** - Exhaust flange
- **f** - Bolt, washer, and nut (3)
- **g** - Clamp
- **h** - External flapper

2. Tighten the screws and the nuts securely.
3. Install the water shutter.

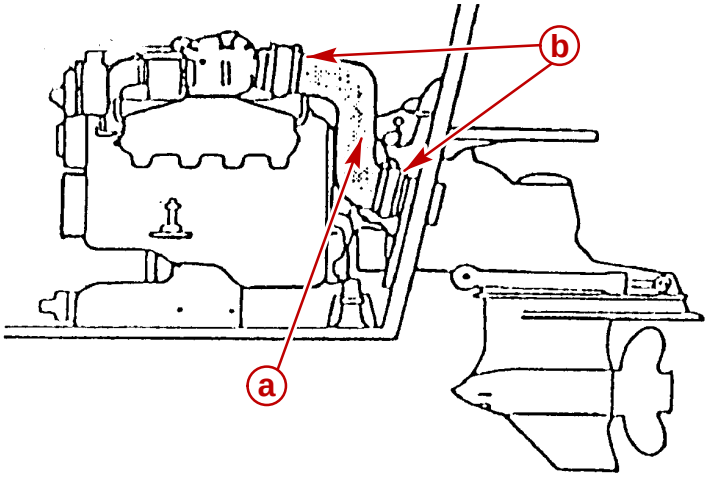
IMPORTANT: Each exhaust hose connection must be double clamped at each connection. Tighten the hose clamps securely.

4. Install the exhaust hoses and 2 hose clamps at each connection. Tighten the hose clamps securely.
5. Inspect the external flappers, and replace if necessary.
   a. Ensure that the hinge mechanism is working properly. The flapper should close immediately without restrictions.
   b. Ensure that the rubber is not torn and is in good condition

Below Swim Platform Exhaust Pipe

Removal

1. Drain the seawater section of the engine.
2. Loosen the hose clamps from the exhaust pipe.
3. Remove the exhaust pipe.



72742

a - Exhaust pipe
b - Hose clamps

Cleaning And Inspection

1. Check the water passages for foreign material. The passages must be clean for efficient cooling.
2. Inspect the exhaust pipe for deep scratches, cuts, and cracks.
3. Inspect for damaged metal caused by saltwater or exhaust gas corrosion.
4. Inspect for unpainted surfaces. Repaint as needed.
5. Inspect the external flappers.
   a. Ensure that the hinge mechanism is working properly. The flapper should close immediately without restrictions.
   b. Ensure that the rubber is not torn and is in good condition.
6. Replace all damaged components.

Installation

1. Install the exhaust pipe to the exhaust tubes and hoses.

IMPORTANT: Each exhaust hose connection must be double clamped at each connection. Tighten hose clamps securely.

2. Secure with 2 hose clamps at each connection.
3. Tighten hose clamps securely.

⚠ CAUTION

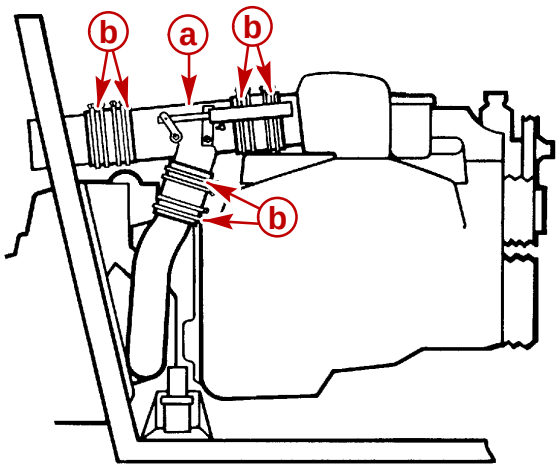
Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

4. Provide sufficient water supply to water inlet holes.
5. Start the engine and check for exhaust and water leaks.

Silent Choice Exhaust System

Removal

1. Drain the seawater section of the cooling system.
2. Disconnect the air tube to the silencer valve assembly.
3. Loosen the hose clamps from the silencer valve assembly.



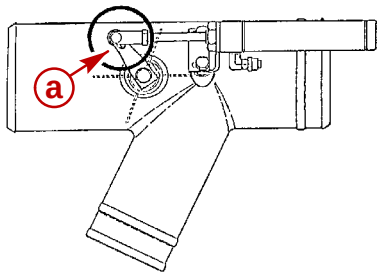
72539

a - Silencer valve assembly
b - Hose clamps

4. Remove the silencer valve assembly.

Cleaning and Inspection

1. Inspect the water passages for foreign material. The passages must be clean for efficient cooling.
2. Inspect for cracks.
3. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches or water and exhaust leaks may result.
4. Inspect for damaged metal caused by saltwater or exhaust gas corrosion in the silencer valve assembly. Replace all damaged components.
5. Lubricate the air cylinder-to-silencer pipe flapper at the clevis and pin, as needed.



72778

a - Clevis and pin

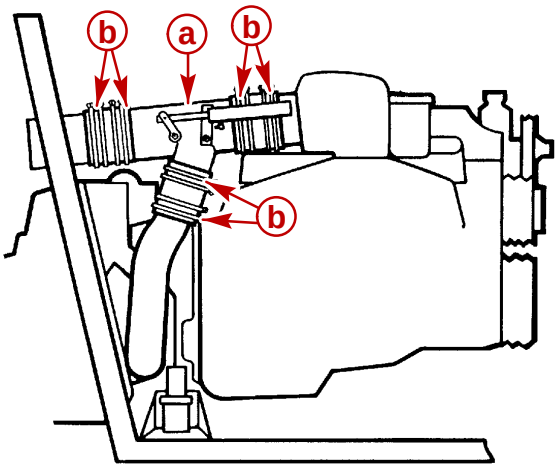
Description	Where Used	Part Number
2-4-C with Teflon	Air cylinder to silencer pipe flapper at clevis and pin	92-802859A1

Installation

1. Install the silencer valve assembly to the exhaust tubes, the hoses, and the Y-pipe.

IMPORTANT: Each exhaust hose connection must be double clamped at each connection. Tighten the hose clamps securely.

2. Secure with 2 hose clamps at each connection.
3. Tighten the hose clamps securely.
4. Install the air tube to the silencer valve assembly.
5. Start the engine and check for exhaust and water leaks.

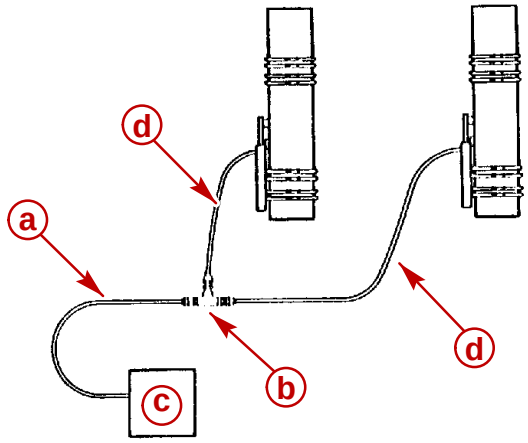


72539

a - Silencer valve assembly
b - Hose clamps

Air Tube Routing

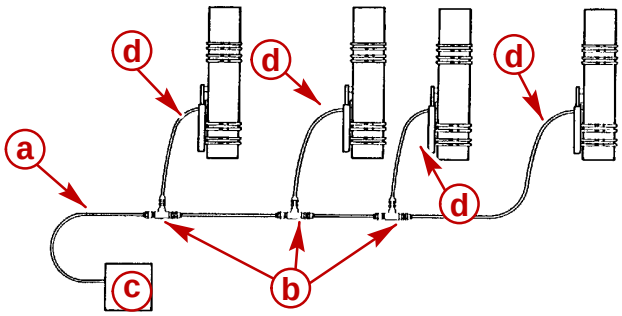
1. Route the air tubing from the air pump to the silencer valve cylinders. Do not route the air tubing close to hot surfaces. Excessive heat will damage the air tubes.



72775

Single engine

a - Air tube
b - T-fittings
c - Air pump assembly
d - Air tube to air cylinder



72776

Dual engine

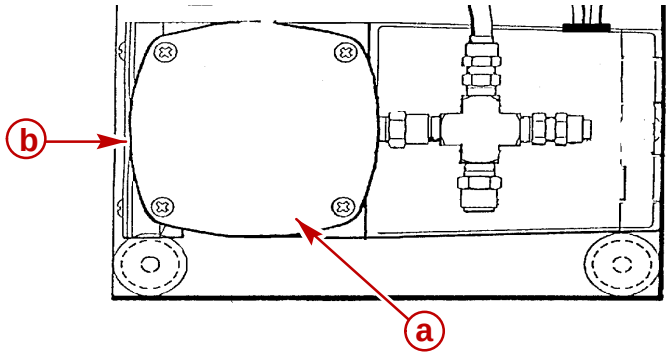
a - Air tube
b - T-fittings
c - Air pump assembly
d - Air tube to air cylinder

Air Pump Maintenance

1. The air intake filter must be inspected annually. If the filter is clogged or partially clogged, replace.
2. Remove the filter pad with needle-nose pliers.
3. Clean the surface in the casting.
4. Apply a single dot of adhesive to the center of the casting.

Description	Where Used	Part Number
Bellows Adhesive	Air pump intake filter	92-86166Q1

5. Install the new filter. Be careful not to coat the filter or clog the air intake holes with the adhesive.



72534

a - Air pump
b - Air intake filter

Troubleshooting Silent Choice Exhaust Silencer System

NOTE: *Perform the following tests with engines not operating.*

COMPRESSOR WILL NOT OPERATE - TESTING MODE SWITCH

Cause	Special Information
PUR wire does not have battery voltage.	Fuse is blown or wiring is faulty.
BRN wire does not have battery voltage when mode switch is held in through the transom position.	Switch is faulty.
GRY wire does not have battery voltage when mode switch is held in through the propeller position.	Switch is faulty.

COMPRESSOR WILL NOT OPERATE - TESTING AIR PUMP

Cause	Special Information
NOTE: *Ensure that BLK wire in terminal block is grounded to engine.*	
BRN wire, in terminal block, does not have battery voltage when mode switch is held in through the transom position.	Wiring is faulty. If voltage is present, air pump is faulty.

AIR PUMP OPERATES - SYSTEM INOPERATIVE

With air pump operating, check hoses, fittings, solenoid, and relief valve for air leakage. Replace parts as needed.

System operates but goes through the prop after air pump stops running.

1. Ensure that air pressure is not leaking past solenoid. Replace as necessary.
2. Ensure that air pressure is not leaking back through air pump. Replace check valve if necessary.
3. Ensure that air pressure is not leaking at air cylinder assemblies. Replace as necessary.

System stays in through the transom mode, will not go back to through the prop mode.

GRY wire, in terminal block, must have battery voltage when mode switch is held in through the prop position. If not, wiring is faulty. If voltage is present, solenoid is faulty.

DRIVES

Section 8A - Velvet Drive In-Line And V-Drive Transmission

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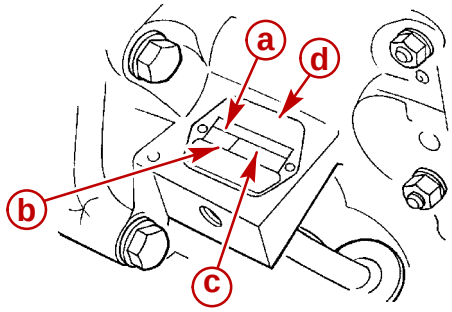
8A

Identification

The transmission identification plate is located on the top left side of the transmission.



72839

Typical transmission identification plate

- **a** - Model number
- **b** - Ratio (in FORWARD gear)
- **c** - Serial number
- **d** - Identification plate model color code

Specifications

Operating Specifications

Description	Specification	
	Open	Closed
Temperature switch settings +/– 10 degrees	87.8 degrees C (190 degrees F)	110 degrees C (230 degrees F)

Ratios And Part Numbers

NOTE: *The ratio is shown on the identification plate. The ratio may be rounded off in some cases.*

71C

Ratio in Forward Gear	Identification Plate Color Code	Velvet Drive Model Number	Mercury Marine Part Number
1.0:1	Red	10-17-004	47805A7
1.5:1		10-17-006	47806A7
2.5:1		10-17-012	47808A7

72C V-DRIVE

Ratio in Forward Gear	Identification Plate Color Code	Velvet Drive Model Number	Mercury Marine Part Number
1.5:1	Green	10-05-011	60959A6
2.0:1		10-05-002	60960A6
2.5:1		10-05-005	60961A6 gear
2.5:1		10-05-004	60961A8 chain

72C

Ratio in Forward Gear	Identification Plate Color Code	Velvet Drive Model Number	Mercury Marine Part Number
1.0:1	Green	10-18-002	47810A19
1.5:1		10-18-004	47811A7
2.0:1		10-18-006	47812A7
2.5:1		10-18-010	47813A7
3.0:1		10-18-012	47814A7

Fluid Specifications

NOTICE
Unit Of Measurement: Liters (U.S. Quarts)
All capacities are approximate fluid measures.

NOTE: *Always use the dipstick to determine the exact fluid level.*

Model	Capacity	Fluid Type
71C In-Line[1]	1.66 (1-3/4)	Dexron III Automatic Transmission Fluid or Mobil 424 Do Not Mix!
71C Gear Reduction[1]	2.84 (3)	
71C Remote V-Drive[1]	1.66 (1-3/4)	
72C In-Line[2]	1.66 (1-3/4)	Mobil 424 or Universal Tractor Hydraulic Oil Do Not Mix!
72C Gear Reduction[2]	2.84 (3)	
72C Remote V-Drive[2]	1.66 (1-3/4)	
72C V-Drive[2]	3.79 (4)	

[1] *71C transmission displays a RED identification label*

[2] *72C transmission displays a GREEN identification label*

Pressure Specifications

Engine rpm	Neutral Gear kPa (psI)		Forward Gear kPa (psI)		Reverse Gear kPa (psi)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
250	–	–	483 (70)	–	483 (70)	–
600	793 (115)	931 (135)	793 (115)	965 (140)	827 (120)	965 (140)
2000	–	–	862 (125)	1103 (160)	862 (125)	1103 (160)
3000	–	–	931 (135)	1241 (180)	–	–

Lubricants / Sealants / Adhesives

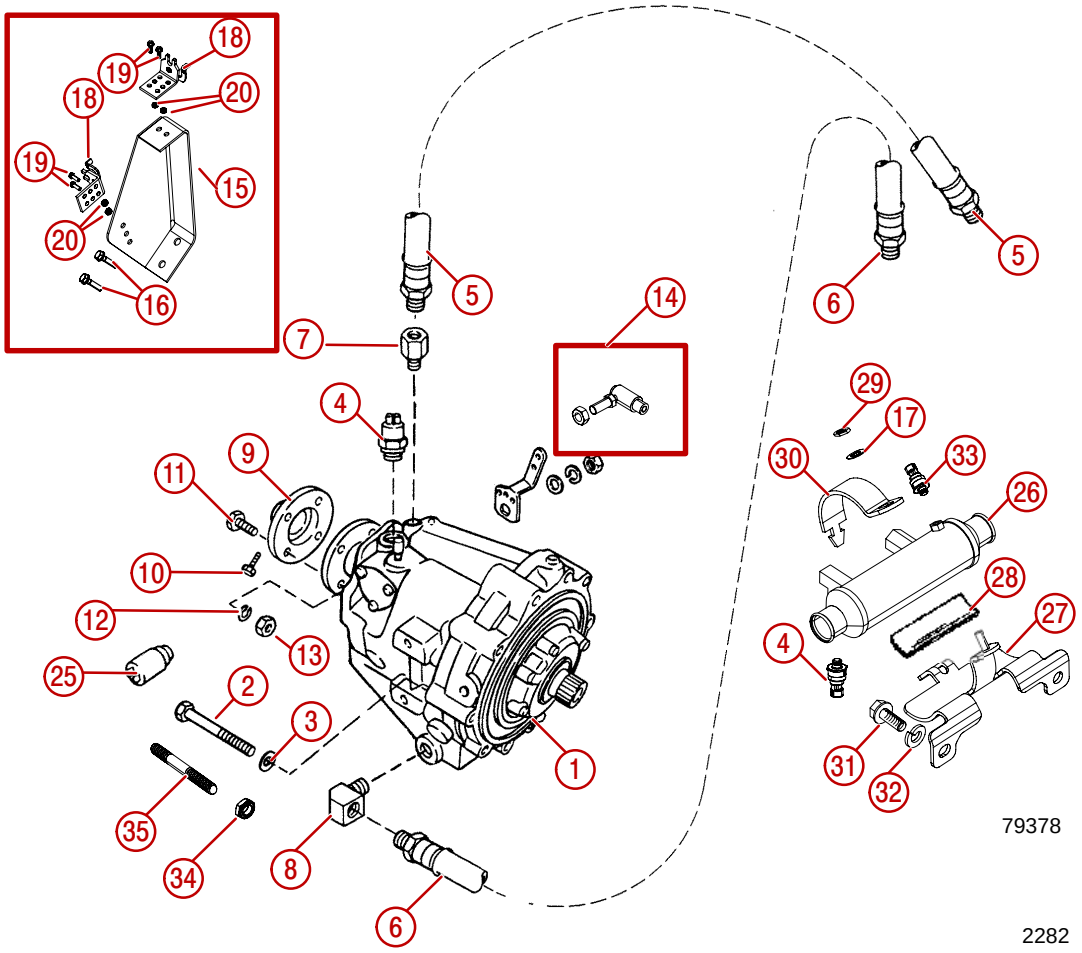
Description	Where Used	Part Number
Perfect Seal	Bushing threads	92-34227-1
	Elbow fitting threads	
2-4-C with Teflon	Transmission shift lever poppet ball, spring, and holes	92-802859A1
Engine Coupler Spline Grease	Transmission input shaft splines and engine drive plate splines	92-802869A1
Loctite 242 Threadlocker	Transmission bracket retention bolts	92-809821

Equivalent products may be used.

Precautions

- Do not start or crank the engine without fluid in the transmission.
- Except in an emergency, do not shift the transmission at engine speeds above 1000 rpm.
- Free wheeling of one propeller (in a twin engine boat) at trolling speeds will not cause damage to the transmission. However, boat operation above trolling speed should be avoided. Ensure that the proper fluid level exists before free wheeling the propeller.
- Do not paint the shift lever poppet ball and spring. An accumulation of paint will prevent proper action of the detent.
- Always replace the oil cooler and the hoses after a transmission failure or prior to installing a new or rebuilt transmission. Metallic particles from a failure tend to collect in the cooler and hoses and will gradually flow back into the fluid system and damage the transmission.
- Always use the specified oil cooler, hoses, and fittings. The hoses must be at least 10.5 mm (13/32 in.) ID The oil cooler, hoses, and fittings must be sufficient size to maintain the transmission fluid (in sump) at 60-88 degrees C (140-190 degrees F).
- Shift cables must be adjusted so that the remote control and the shift cable position the shift lever correctly.
- Do not change propeller rotation by reversing the shift lever.
- Engine alignment must be performed with the boat at rest in the water.

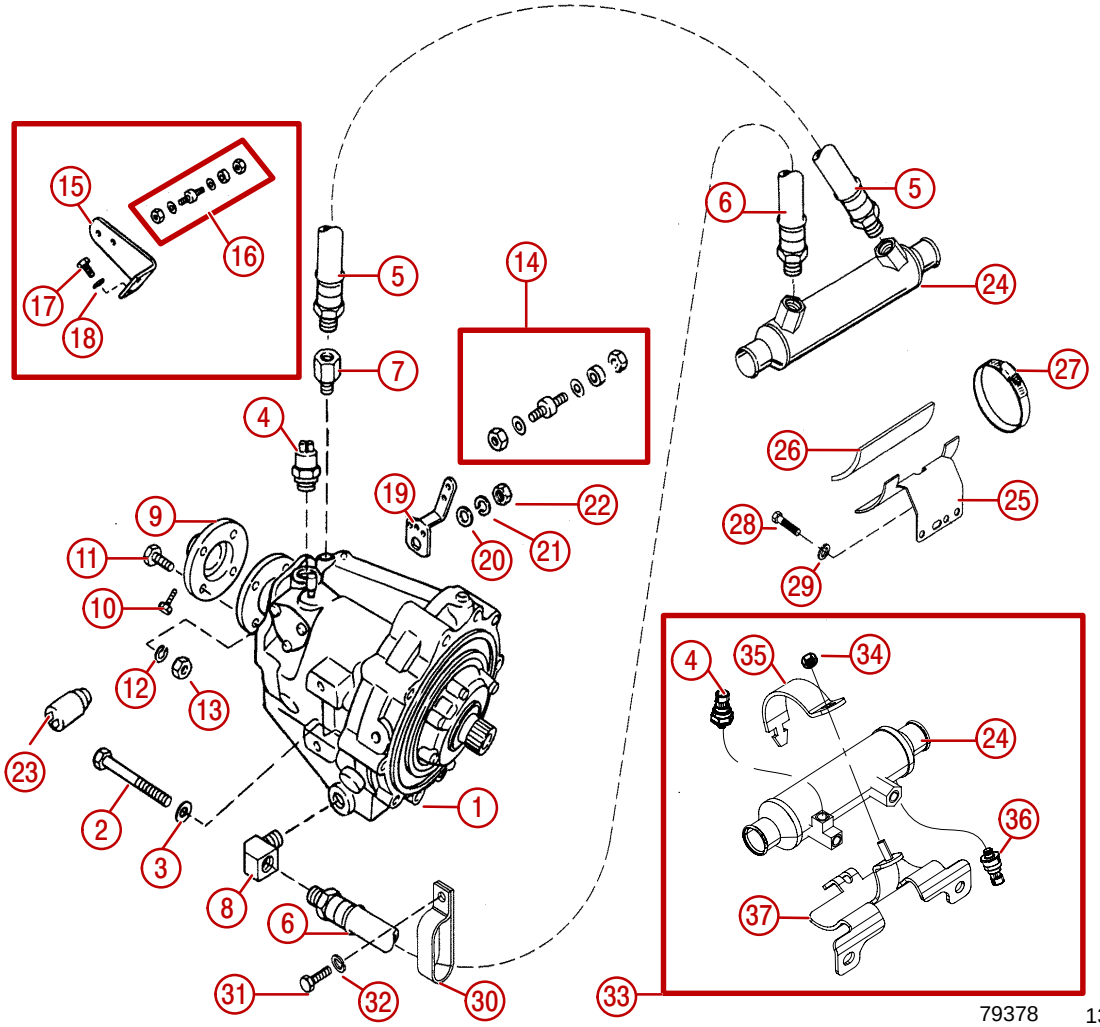
Transmission and Related Parts



Scorpion setup 71C, other Tow Sports similar

1 - 71C transmission
2 - Screw
3 - Lockwasher
4 - Temperature switch
5 - Oil hose
6 - Oil hose
7 - 45 degree elbow
8 - 90 degree elbow
9 - Flange assembly
10 - Screw
11 - Bolt
12 - Lockwasher
13 - Nut
14 - Ball joint assembly
15 - Bracket assembly
16 - Screw
17 - Washer
18 - Stud kit
19 - Bolt
20 - Nut
21 - Shift lever
22 - Washer
23 - Lockwasher
24 - Nut
25 - Neutral safety switch
26 - Oil cooler
27 - Cooler bracket
28 - Cooler bracket pad
29 - Nut
30 - Cooler clamp
31 - Screw
32 - Lockwasher
33 - Pressure sensor
34 - Nut
35 - Stud

Transmission and Related Parts (continued)



Inboard set up 71C

1 - 71C Transmission
2 - Screw
3 - Lockwasher
4 - Temperature switch
5 - Oil hose
6 - Oil hose
7 - Straight adapter or 45 degree elbow
8 - 90 degree elbow
9 - Flange assembly
10 - Screw
11 - Bolt
12 - Lockwasher
13 - Nut
14 - Stud kit
15 - Bracket assembly
16 - Stud kit
17 - Screw
18 - Lockwasher
19 - Shift lever
20 - Washer
21 - Lockwasher
22 - Nut
23 - Neutral safety switch
24 - Oil cooler
25 - Cooler bracket
26 - Cooler bracket pad
27 - Cooler clamp
28 - Screw
29 - Lockwasher
30 - Clamp, double hose
31 - Screw
32 - Lockwasher
33 - New cooler bracket assembly
34 - Nut
35 - Cooler clamp
36 - Pressure sensor
37 - Cooler bracket

Torque Specifications

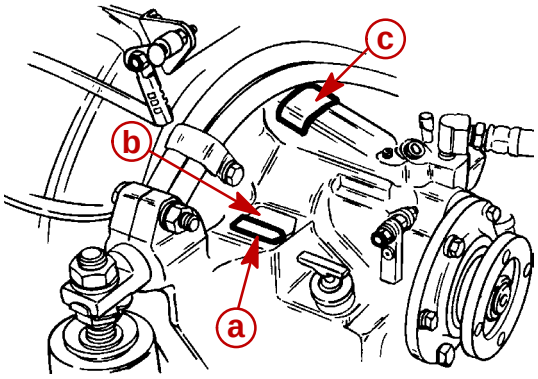
NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb-in.	lb-ft
Bushing	33.8		25
Fluid hose to bushing	33.8		25
Pump housing to adapter	25.7		19
Rear mounts to transmission	61		45
Shift lever to valve	12	115	
Transmission to flywheel housing	67.7		50
Neutral start safety switch	12	115	
Propeller shaft coupler to output flange	67.7		50
Shift lever nut	12	115	

Transmission / Propeller Rotation

Identification

On the Velvet Drive 71C In-Line Transmissions the gear ratio (in FORWARD gear) is marked on transmission identification plate. Transmission output shaft rotation and propeller rotation required (in FORWARD gear) are indicated on a decal on the transmission case. Transmission rotation is described when viewed from the rear of transmission.



22556

a - Transmission identification plate
b - Gear ratio (in FORWARD gear)
c - Output flange rotation decal (in FORWARD gear)

General Information

⚠ CAUTION

Velvet Drive In-Line Transmissions Only - Use of proper rotation propeller (specified on transmission output flange rotation decal) is critical since the transmission must be operated in FORWARD gear selector position only to drive boat forward. If the wrong rotation propeller is installed and transmission is operated in reverse to propel the boat forward, transmission failure WILL occur.

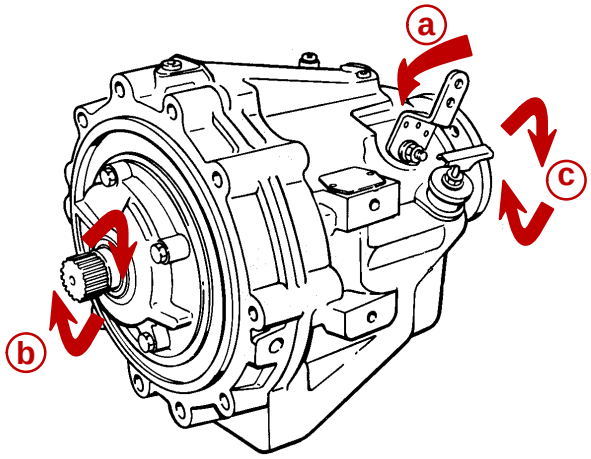
IMPORTANT: On engines equipped with Velvet Drive In-line transmissions, a LH propeller is required.

These transmissions have a left-hand (LH) output flange rotation when in FORWARD gear. This is the same as the engine rotation and is referenced from the rear of the engine. A LH rotation propeller must be used on these applications (except a Walter V-drive application where the rotation is established by the gear box). The transmission can only be operated under full power when in the FORWARD gear position.

On MIE engines equipped with in-line transmissions having 1:1 gear ratio, the transmission output shaft rotation is the same as the engine rotation with the transmission in FORWARD gear. Engine rotation is LH (CCW), so a LH propeller is required.

NOTE: *71C and 72C transmissions are not full power reversing.*

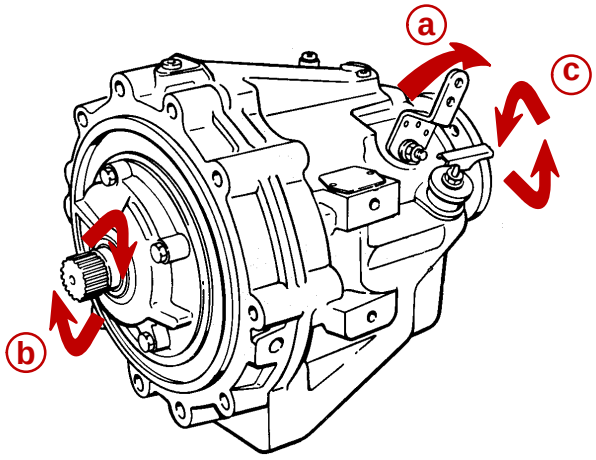
NOTE: *Shift cables must be adjusted so that the remote control and the shift cable position the shift lever correctly.*



77966

Forward

a - Direction of shift lever engagement (toward flywheel)
b - Engine/transmission input shaft rotation direction (LH)
c - Transmission output/propeller shaft rotation direction (LH)



77966

Reverse

a - Direction of shift lever engagement (away from flywheel)
b - Engine/transmission input shaft rotation direction (LH)
c - Transmission output/propeller shaft rotation direction (RH)

Fluid Level

Checking

⚠ WARNING

Do not remove the dipstick with the engine operating. Hot oil can cause burns.

⚠ CAUTION

Clean around the area of the dipstick before removing. Small particles of dirt can cause damage to internal components and cause the valves to stick.

WARM

NOTE: *Checking the transmission fluid level while warm requires 2 people as the level begins to rise within 2 seconds of stopping the engine. For convenience and to ensure accurate readings, it is recommended that a cold fluid full mark is made and the cold fluid procedure is followed.*

1. Loosen the dipstick by turning the T-handle COUNTERCLOCKWISE until it moves freely within the dipstick tube. Leave the handle inserted fully in the dipstick tube.
2. Start the engine and operate in NEUTRAL at 1500 rpm for 2 minutes.
3. Stop the engine.
4. Immediately remove the dipstick and wipe it clean.

IMPORTANT: Push the dipstick all the way down into the dipstick tube when checking fluid level.

5. Insert the dipstick fully into the transmission, withdraw it, and read the fluid level. Fluid level should be up to full mark. If low, add specified fluid through dipstick tube on transmissions.
   a. Allow approximately 15 seconds for the fluid to settle; insert the dipstick.
   b. Start the engine and operate for 60 seconds. Shut engine off.
   c. Repeat steps 2.-5. until correct fluid level is obtained.

COLD

NOTE: Cold Fluid Level Check: *Checking the fluid level before starting the engine is the preferred method to assure correct operating level. The dipstick should be marked or scribed with a cold level mark.*

1. Follow the procedure for the warm fluid level check to ensure the transmission is full and then allow the boat to sit overnight.

IMPORTANT: Push the dipstick all the way down into the dipstick tube when checking the fluid level.

2. Remove the dipstick, wipe clean, and reinsert.
3. Remove the dipstick, observe the fluid level, and mark the cold fluid level.
4. Reinstall the dipstick and tighten the T-handle securely. Do not overtighten.
5. Future checks can be made when the transmission fluid is cold:
   a. Remove the dipstick and wipe it clean.
   b. Reinsert the dipstick and remove to observe the fluid level.

Refer to **Section 1B - Maintenance**.

Changing

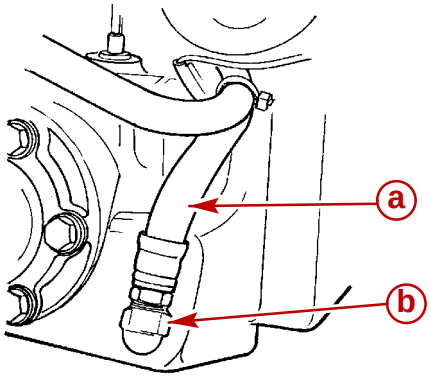
IMPORTANT: Do not start or crank the engine without fluid in the transmission.

Transmission fluid should be changed, the transmission cooler should be replaced, and the lines should be flushed when servicing the transmission.

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

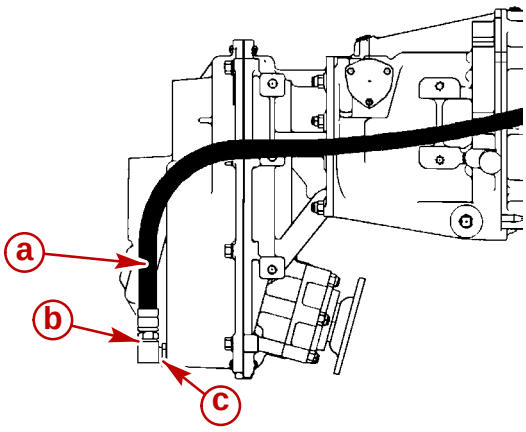
1. Clean the area around the cooler hose.
2. Disconnect the hose from the elbow fitting.
3. Remove the elbow fitting from the bushing.



72840

Typical In-line model

a - Cooler hose
b - Elbow fitting

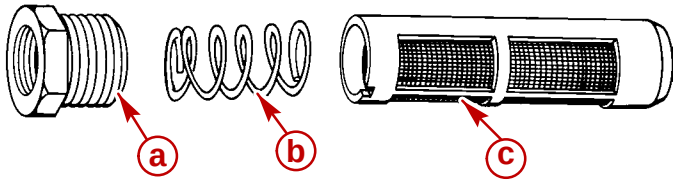


71305

Typical V-drive model

a - Cooler hose
b - Elbow fitting
c - Bushing

4. Drain the oil from the transmission, cooler, and cooler hoses into a suitable container.
5. Remove the bushing, spring, and plastic strainer tube from the transmission case. Allow the transmission to drain completely.



71307

a - Bushing
b - Spring
c - Plastic strainer tube

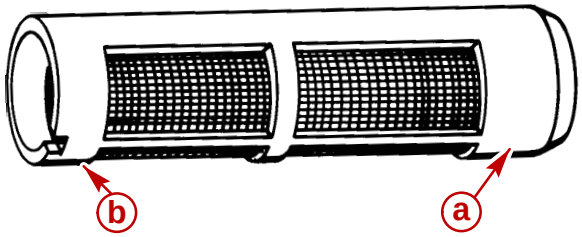
6. Clean the plastic strainer tube in suitable solvent.
7. Check the oil for the following foreign matter:

- **Metal Particles -** A few small particles are normal. Larger metal chips are an early sign of transmission failure, which may mean the transmission should be disassembled and inspected for internal damage.
- **Rubber Particles -** Indication of cooler hose wear. The hoses should be inspected for cracks or fraying. Replace damaged hoses.
- **External Debris -** Examples of external debris include sea weed and eel grass.

⚠ CAUTION

Avoid severe transmission damage or possible failure of the transmission. The strainer must be properly installed.

8. Install the plastic strainer tube with the notch DOWN and OUT toward the side of the case.



71306

a - Plastic strainer tube
b - Notch

9. Install the spring.
10. Coat the bushing threads with sealant. Install and torque the bushing.

Description	Where Used	Part Number
Perfect Seal	Bushing threads	92-34227-1

Description	Nm	lb-in.	lb-ft
Bushing	33.8		25

11. Coat the elbow fitting threads with sealant and install in the bushing. Tighten securely.

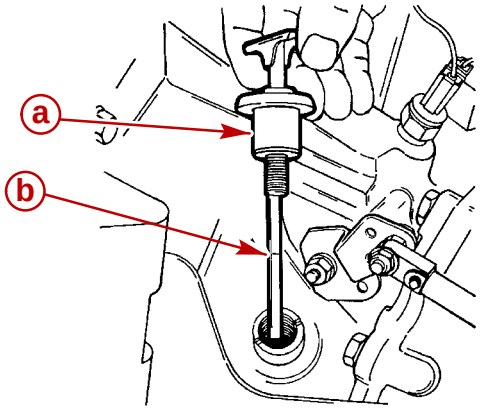
Description	Where Used	Part Number
Perfect Seal	Elbow fitting threads	92-34227-1

12. Reconnect the hose and tighten securely.
13. Fill the transmission with specified fluid.
14. Follow the warm fluid procedure to ensure that the lines and cooler are adequately filled prior to checking fluid level.

Filling

IMPORTANT: Use only specified transmission fluid.

1. Remove the dipstick.
2. Fill the transmission with fluid through the dipstick hole to bring the level up to the full mark.



72526

a - Dipstick
b - Full mark

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

IMPORTANT: To accurately check the fluid level, operate the engine at 1500 rpm for 2 minutes immediately prior to checking the fluid level.

3. Start the engine and operate at 1500 rpm for 2 minutes to fill all hydraulic circuits.

IMPORTANT: Be sure to push the dipstick all the way down into the dipstick tube when checking the fluid level.

4. Stop the engine and quickly check the fluid level. Add transmission fluid, if necessary, to bring the level up to the full mark on the dipstick.
5. Reinstall the dipstick; tighten the T-handle securely. Do not overtighten.

Removal

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

NOTICE

The following procedure describes removal of the transmission without removing the engine. If the engine must be removed, refer to Section 2.

1. Disconnect both battery cables.
2. Drain the transmission fluid.
3. Disconnect the fluid cooler hoses.

NOTE: *Fluid cooler should be removed with transmission.*

4. Disconnect the shift cable from the transmission.
5. Disconnect the wires from the neutral start safety switch.
6. Disconnect the wires from the transmission fluid temperature switch, if applicable.
7. Disconnect the propeller shaft coupling.

8. Remove the 4 rear mount to engine bed fasteners and hardware.
9. Support the rear part of the engine with a hoist or put wooden blocks under the flywheel housing.
10. Remove the 2 center transmission to flywheel housing attaching bolts and install 2 long studs.

IMPORTANT: These 2 long studs will help support the weight of the transmission during removal and installation.

11. Remove the remaining transmission attaching bolts.
12. Pull the transmission straight back and away from engine to completely disengage splines on input shaft.
13. Carefully lift out transmission.

Installation

1. Apply lubricant to the transmission input shaft splines and the engine drive plate splines.

Description	Where Used	Part Number
Engine Coupler Spline Grease	Transmission input shaft splines and engine drive plate splines	92-802869A1

2. If removed, install the rear engine mounting brackets. Torque the fasteners.

Description	Nm	lb-in.	lb-ft
Rear mounts to transmission fasteners	61		45

3. Using a suitable hoist, position the transmission in the boat and align the transmission input shaft splines with the engine drive plate splines.
4. Slide the transmission into place and secure with bolts.
5. Remove the 2 long studs (installed in Step 10. of Removal) and install the remaining 2 bolts. Torque all fasteners.

Description	Nm	lb-in.	lb-ft
Transmission to flywheel housing fasteners	67.7		50

6. Using a hoist, raise engine and transmission to remove blocks (if used).
7. Lower assembly to engine bed.
8. Relieve the hoist tension and fasten the rear engine mounts to the engine bed. Tighten the bolts securely.
9. Connect the wires to the neutral start safety switch.
10. Connect the wires to the fluid temperature switch, if applicable.
11. Connect the fluid cooler hoses and tighten the hose clamps securely.

⚠ CAUTION

Improper shift cable connection and adjustment can cause premature clutch failure.

12. Connect and adjust the shift cables. Refer to Installation and Adjustment.
13. Check the engine final alignment. Refer to **Section 2B**.
14. After the engine has been properly aligned, connect the propeller shaft coupler to the transmission output flange with bolts, lockwashers, and nuts. Torque the fasteners.

Description	Nm	lb-in.	lb-ft
Propeller shaft coupler to output flange fasteners	67.7		50

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

15. Refill the transmission with specified fluid.
16. Connect both battery cables. Tighten the clamp securely.
17. Start the engine and check for leaks.
18. Check the fluid level.

Shift Lever Installation

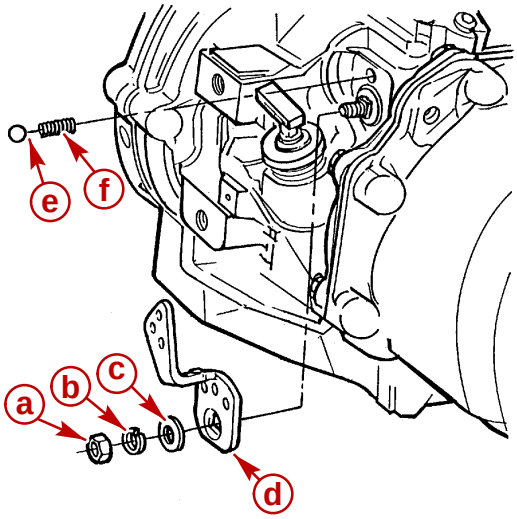
IMPORTANT: The Velvet Drive Warranty is jeopardized if the shift lever poppet spring and/or ball is permanently removed, or if the shift lever is changed, repositioned or if the linkage between the remote control and the transmission shift lever does not have sufficient travel in both directions.

The shift lever and related parts must be assembled as shown.

1. Lubricate the poppet ball, spring and holes in the shift lever.

Description	Where Used	Part Number
2-4-C with Teflon	Transmission shift lever poppet ball, spring, and holes	92-802859A1

2. Install the poppet spring and ball. Retain the ball by placing the shift lever on the shaft.
3. Install the flat washer, lockwasher, and nut on the shaft.
4. Torque the nut.



72844

Typical shift lever

- **a** - Nut
- **b** - Lockwasher
- **c** - Flat washer
- **d** - Shift lever
- **e** - Poppet ball
- **f** - Poppet spring

Description	Nm	lb-in.	lb-ft
Shift lever nut	12	115	

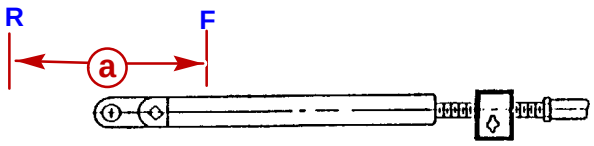
5. After installation, move the shift lever through the FORWARD, NEUTRAL and REVERSE positions. No more than finger-tip effort should be required. If it binds, the cause for binding must be found and corrected.

Shift Control And Cables

IMPORTANT: The Velvet Drive Warranty is jeopardized if the shift lever poppet ball or the spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if the remote control and the shift cable do not position the shift lever correctly.

The remote control used must position the transmission shift lever over the letter “F” embossed on the transmission case when the remote control is placed in the FORWARD gear position. Transmission failure will occur if the transmission shift lever is positioned over the letter “R” and the wrong rotation propeller is used to propel boat forward.

The remote control must provide shift cable travel (at the transmission) of at least 70 mm (2-3/4 in.) to position the transmission shift lever fully in the FORWARD and the REVERSE gear positions. Insufficient shift cable travel will cause the transmission to slip and eventually fail.



72602

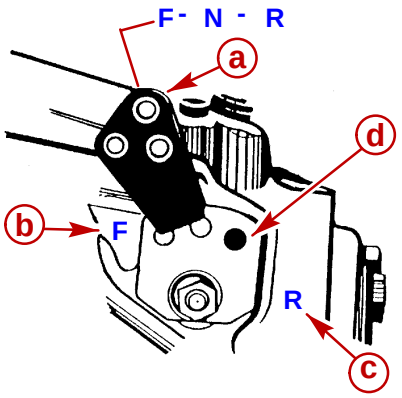
a - 70 mm (2-3/4 in.) minimum

Description	Specification
Shift cable travel	70 mm (2-3/4 in.)

Transmission Shift Lever and Shift Cable Bracket

IMPORTANT: The Velvet Drive Warranty is jeopardized if the shift lever poppet ball or the spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if the remote control and the shift cable do not position the shift lever correctly.

The lever has 3 holes as illustrated following. The shift lever stud is placed in the forward-middle hole when using Quicksilver remote control cables.



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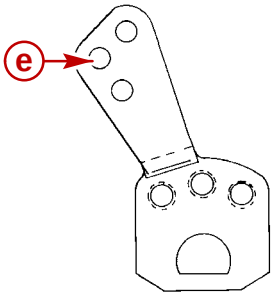


71301

a - Transmission shift lever
b - Shift lever must be over this letter when propelling boat FORWARD
c - Shift lever must be over this letter when propelling boat in REVERSE
d - Poppet ball must be centered in detent hole for each F-N-R position (FORWARD gear shown)
e - Shift cable anchor stud location

IMPORTANT: The distance between the anchor studs in the shift lever and the shift cable bracket must be 181 mm (7-1/8 in.).

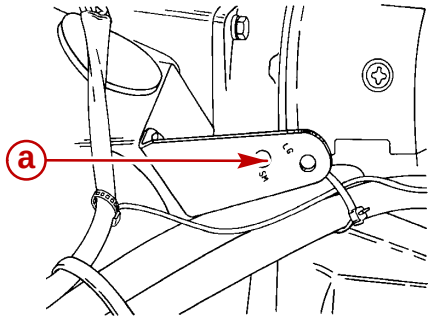
Installation and Adjustment (Excluding Scorpion Models)

IMPORTANT: When installing shift cables, ensure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. Do not fasten any items to the shift cables.

NOTE: *On models with other than Quicksilver shift cables, refer to the shift cable manufacturer's instructions.*

IMPORTANT: The Velvet Drive Warranty is jeopardized if the shift lever poppet ball or the spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if the remote control and the shift cable do not position the shift lever correctly.

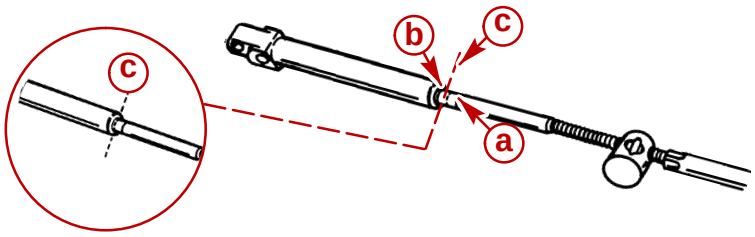
1. Verify that the shift cable stud is in appropriate stud hole as indicated. Tighten the elastic stop nut securely.



50947

a - Shift cable anchor stud hole

2. Place the remote control shift lever and the transmission shift lever in the NEUTRAL position.
3. Remove the nuts and washers from the shift cable attaching studs.
4. Locate the center of the remote control and the control shift cable play (backlash), as follows:
   a. Ensure that the remote control is in the NEUTRAL position.
   b. Push in on the control cable end with enough pressure to remove the play and mark position "**a**" on the tube.
   c. Pull out on the control cable end with enough pressure to remove the play and mark position "**b**" on the tube.
   d. Measure the distance between marks "**a**" and "**b**," and mark position "**c**," halfway between marks "**a**" and "**b**."



22024

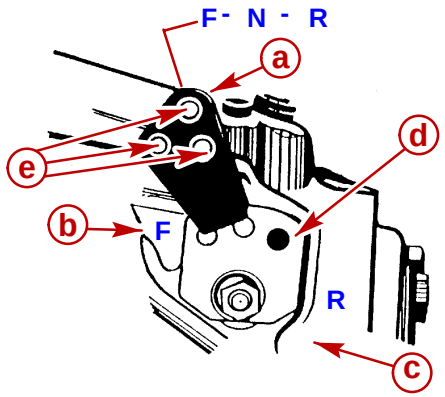
5. Center the cable-end play, then adjust the cable barrel to align the holes in the barrel and in the cable end guide with the attaching points on the transmission.
6. Install the shift cable. Temporarily, do not secure.

IMPORTANT: Transmission is fully in gear when shift lever comes to a stop in either direction.

⚠ CAUTION

Remote control and shift cable must position transmission shift lever exactly as shown, or transmission failure may occur. Do not remove poppet ball or spring.

7. Place remote control shift lever in gear and check position of transmission shift lever. Shift lever must be positioned correctly.
8. Place remote control shift lever in opposite gear position and check transmission shift lever position. Shift lever must be positioned as shown.



72601

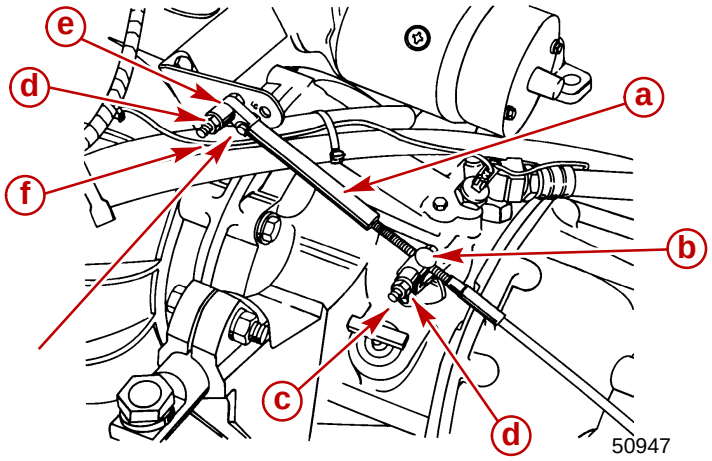
a - Transmission shift lever
b - Shift lever must be over this letter when propelling boat FORWARD
c - Shift lever must be over this letter when propelling boat in REVERSE
d - Poppet ball must be centered in detent hole for each F-N-R position (FORWARD gear shown)
e - Shift lever stud holes

9. If the transmission shift lever will position properly in one gear, but not in the other gear, recheck the shift cable adjustment. If the transmission shift lever will not position properly in either gear, move the transmission shift lever stud from the top hole in the shift lever to the bottom hole and recheck for proper positioning. If proper positioning is still not obtained, the remote control does not provide sufficient shift cable travel and must be replaced.

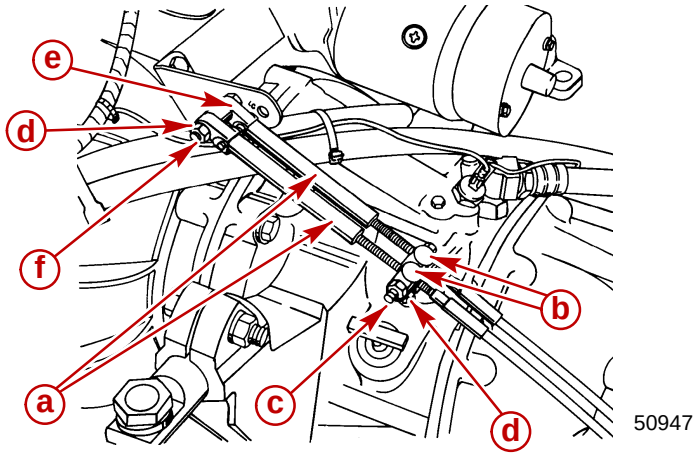
NOTE: *Move the shift lever stud to lower hole if necessary, to center the poppet ball in the FORWARD and REVERSE detent holes.*

10. Install the nut and the washer to the cable end guide stud. Tighten until the nut contacts, then loosen 1/2 turn.

11. Install the nut and the washer to the cable barrel stud. Tighten until the nut contacts. Tighten securely, but do not overtighten.

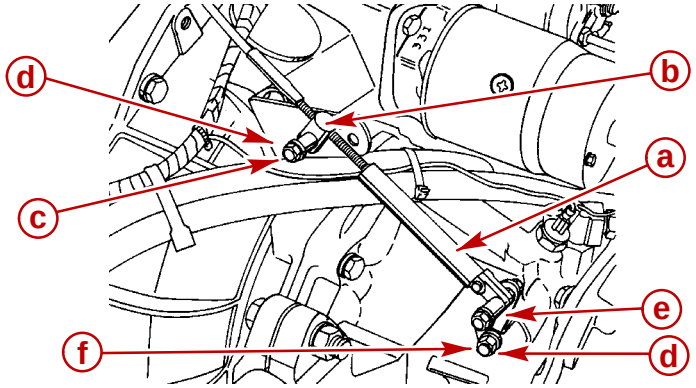


Typical single cable installation - rear approach



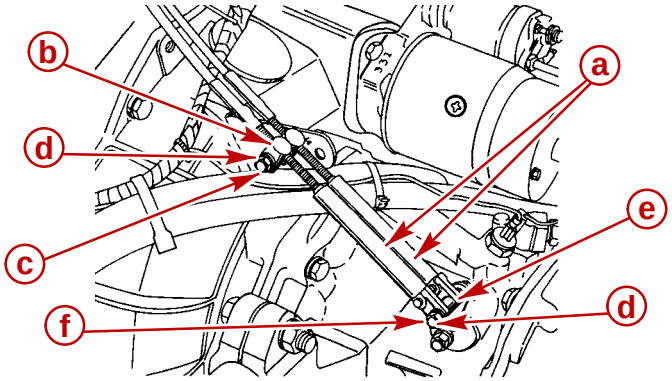
Typical dual cable installation - rear approach

a - Cable end guide
b - Cable barrel
c - Cable barrel stud
d - Elastic stop nut and washer
e - Spacer
f - Cable end guide stud



50946

Typical single cable installation - front approach

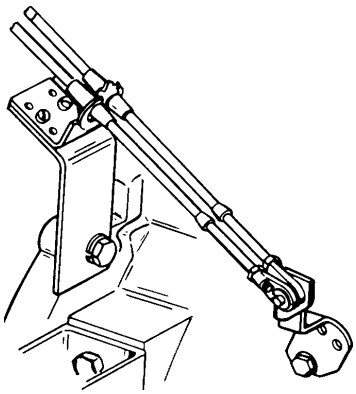


50946

Typical dual cable installation - front approach

- **a** - Cable end guide
- **b** - Cable barrel
- **c** - Cable barrel stud
- **d** - Elastic stop nut and washer
- **e** - Spacer
- **f** - Cable end guide stud

NOTE: *For models equipped with a dual station shift bracket such as the one shown, refer to the shift cable manufacturer's instructions for adjusting the cable. The shift lever must be positioned as stated in the preceding steps.*



22457

Dual station shift bracket (not Quicksilver)

Scorpion Shift Cable Installation And Adjustment

NOTE: *Tow Sports models accommodate single cable forward entry only.*

IMPORTANT: When installing shift cables, ensure that cables are routed in such a way as to avoid contact with moving parts and/or sharp bends All bends must make greater than a 20 cm (8 in.) radius. Do not fasten any items to shift cables.

Shift cable must be connected to the remote control before starting installation and adjustment procedures. Refer to Transmission Propeller Rotation, as previously outlined in the front of this manual, for transmission shift lever direction of movement versus propeller shaft output direction of rotation.

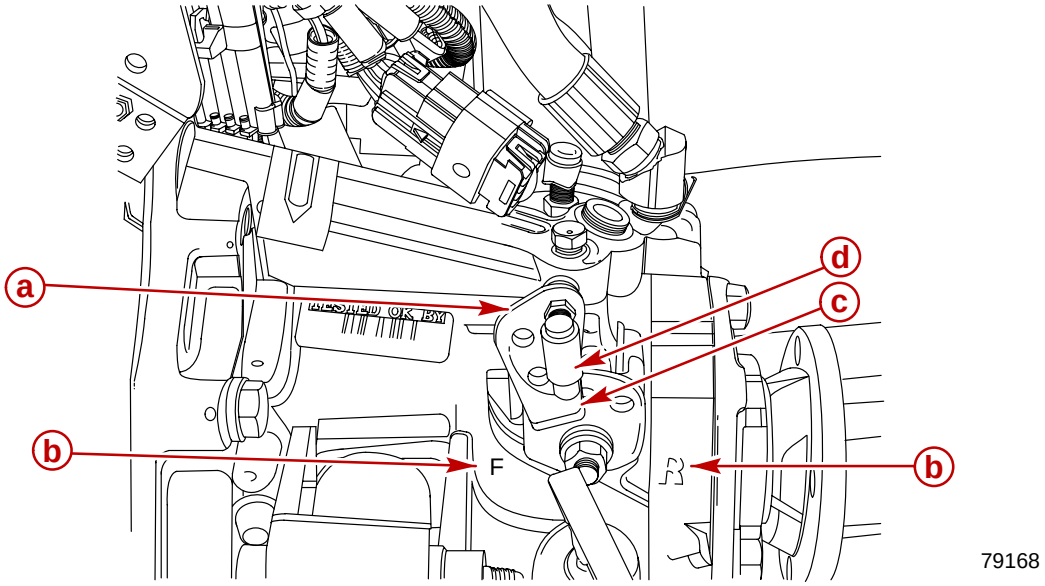
Damage caused to transmission as a result of improper shift lever positioning will not be covered by warranty.

To ensure proper shift and throttle operation, we recommend the use of a Quicksilver remote control and cables. Refer to ***Mercury Precision Parts / Quicksilver Accessories Guide***.

Description	Specification
Shift Cable Travel	70 mm (2-3/4 in.)

Remote control must be set up to retract shift cable when going into FORWARD gear on Velvet Drive 71C in-line transmissions.

IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if remote control and cable do not position shift lever correctly.

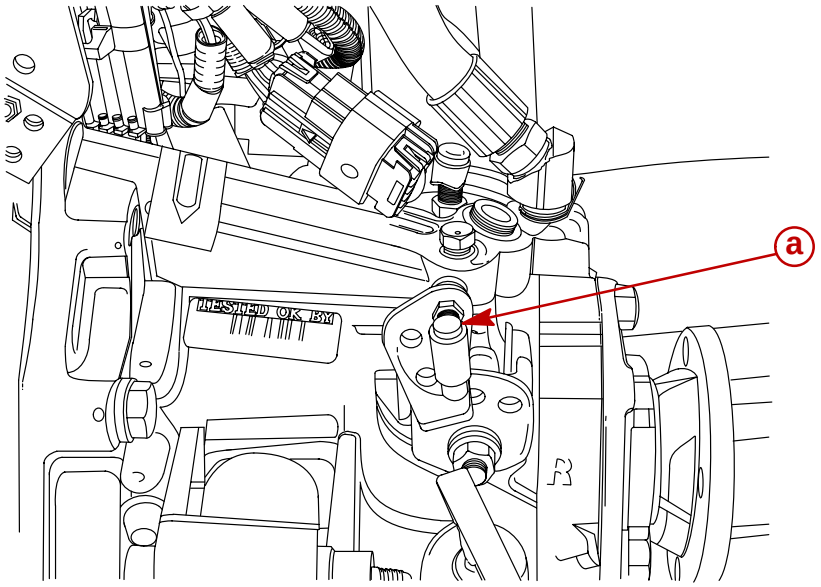


79168

71C In-line shown, other models similar

- **a -** Transmission shift lever
- **b -** Gear designation (NEUTRAL in center)
- **c -** Poppet ball (not visible) MUST BE centered in detent hole for each position (FORWARD gear shown)
- **d -** Shift cable quick connect

1. Verify shift cable stud is in appropriate stud hole as indicated.



79168

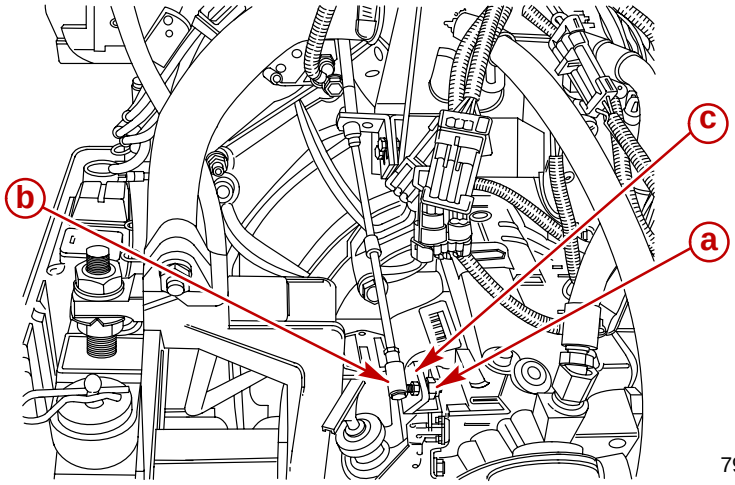
71C In-line shown, other models similar

- **a -** 71C shift cable connection hole

2. Screw cable into quick connect until at least 2 threads are engaged.

NOTE: *Can move barrel into different hole of transmission bracket if necessary for adjustment.*

3. Insert cable into bracket. Bracket can be moved for coarse adjustment.
4. Turn cable barrel to fine tune adjustment.
5. When properly adjusted, hold cable barrel and tighten jam nut securely.

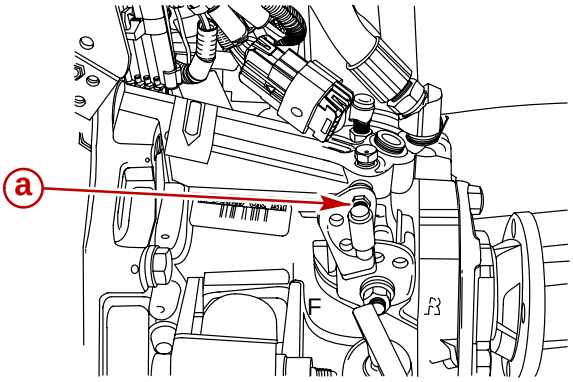


79170

71C In-line shown, others similar

a - Jam nut
b - Cable barrel
c - Bracket

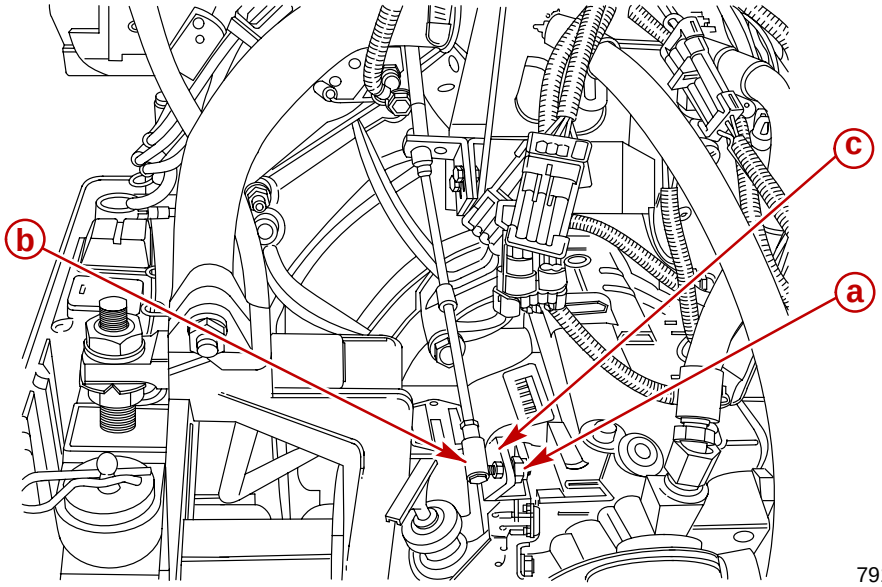
6. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in either gear, move transmission shift lever stud to another hole in the shift lever, and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.



79168

71C In-line shown, other models similar

a - 71C shift cable connection hole



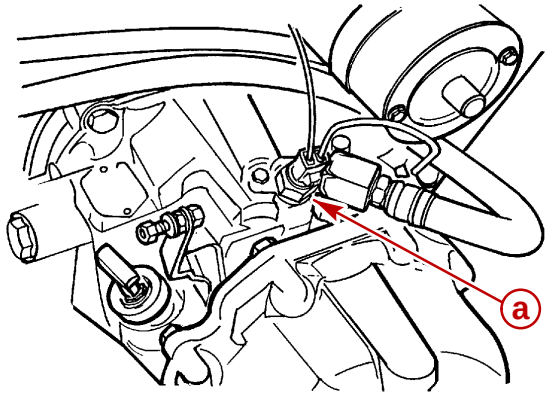
79170

71C In-line shown, others similar

a - Jam nut
b - Cable barrel
c - Bracket

Pressure Test

1. Remove the temperature switch.
2. Install the pressure gauge in the main line pressure tap.



72845

a - Main line pressure tap

3. With the boat in the water, start the engine and operate until the normal operating temperature is reached.
4. Check pressure readings.

Engine rpm	Neutral Gear kPa (psi)		Forward Gear kPa (psi)		Reverse Gear kPa (psi)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
250	–	–	483 (70)	–	483 (70)	–
600	793 (115)	931 (135)	793 (115)	965 (140)	827 (120)	965 (140)
2000	–	–	862 (125)	1103 (160)	862 (125)	1103 (160)
3000	–	–	931 (135)	1241 (180)	–	–

Transmission Repair

Mercury Marine does not stock or sell replacement parts for these transmissions. Velvet Drive has a network of distributors throughout the world to service their product. These distributors, in turn, have a dealer network to service the transmissions. Also, service manuals for each transmission can be obtained from Velvet Drive.

For the location of your closest distributor or service literature contact:

Velvet Drive Transmissions
1208 Old Norris Road
Liberty, SC 29657
U.S.A.
Phone: 864-843-9234
Fax: 864-843-1276
Email: administration@velvetdrive.com

DRIVES

Section 8B - Velvet Drive 5000 Series Transmission

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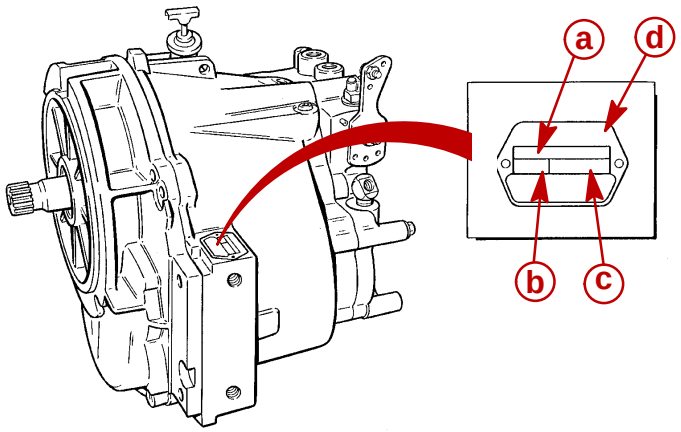
8 B

Identification

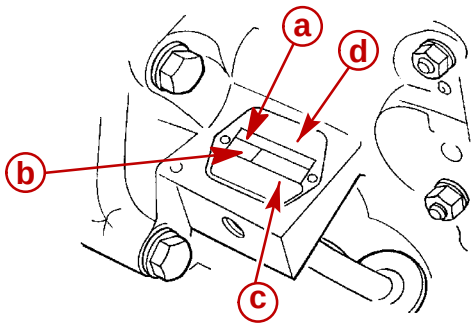
The transmission identification plate is located on the top left side of the transmission.



73247

Velvet Drive 5000A Down Angle transmission identification plate

- **a** - Model number
- **b** - Ratio (in forward gear)
- **c** - Serial number
- **d** - Identification plate model color code



72839

Velvet Drive 5000V V-drive transmission identification plate

- **a** - Model number
- **b** - Ratio (in forward gear)
- **c** - Serial number
- **d** - Identification plate model color code

Specifications

Description	Specification	
	Open	Close
Temperature switch settings +/– 10 degrees	87.8 degrees C (190 degrees F)	110 degrees C (230 degrees F)

Ratios and Part Numbers

NOTE: *The ratio is shown on the identification plate. The ratio may be rounded off in some cases.*

5000A

Ratio in Forward Gear	Identification Plate Color Code	Velvet Drive Model Number	Mercury Marine Part Number
1.25:1	Black	20-01-002	805495A8
1.5:1		20-01-003	805495A6
2.0:1		20-01-004	805495A4
2.5:1		20-01-005	805495A5
2.8:1		20-01-006	805495A7

5000V

Ratio in Forward Gear	Identification Plate Color Code	Velvet Drive Model Number	Mercury Marine Part Number
1.5:1	Blue	20-02-003	807481A5
2.0:1		20-02-004	807481A6
2.5:1		20-02-005	807481A7

Fluid Specifications

NOTICE
Unit Of Measurement: Liters (U.S. Quarts) **All capacities are approximate fluid measures.**

NOTE: *Always use the dipstick to determine the exact fluid level.*

Model	Capacity	Fluid Type
5000A	2.84 (3)	Dexron III Automatic Transmission Fluid or Equivalent
5000V	3.3 (3-1/2)	

Pressure Specifications

Engine rpm	Neutral Gear kPa (psi)		Forward Gear or Reverse Gear kPa (psi)	
	Minimum	Maximum	Minimum	Maximum
900	69 (10)	345 (50)	1724 (250)	2758 (400)
2400	103 (15)	483 (70)		
4500	–	–		

Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Perfect Seal	Drain plug	92-34227-1
Engine Coupler Spline Grease	Transmission input shaft splines and engine drive plate splines	92-802869A1
2-4-C with Teflon	Transmission shift lever poppet ball, spring, and holes	92-802859A1
Loctite 242 Threadlocker	Transmission bracket retention bolts	92-809821

Equivalent products may be used.

Precautions

- Do not start or crank the engine without fluid in the transmission.
- Except in an emergency, never shift the transmission at engine speeds above 1000 rpm.
- Free wheeling of one propeller (in a twin engine boat) at trolling speeds will not cause damage to the transmission. However, boat operation above trolling speed should be avoided. Ensure that the proper fluid level exists before free wheeling the propeller.
- Do not paint the shift lever poppet ball and spring. An accumulation of paint will prevent proper action of the detent.
- Always replace the oil cooler and the hoses after a transmission failure or prior to installing a new or rebuilt transmission. Metallic particles from a failure tend to collect in the cooler and the hoses and will gradually flow back into the fluid system and damage the transmission.
- Always use the specified oil cooler, hoses and fittings. The hoses must be 11 mm (13/32 in.) ID minimum. The oil cooler, hoses and fittings must be sufficient size to maintain the transmission fluid (in sump) at 60-79 degrees C (140-175 degrees F).

Torque Specifications

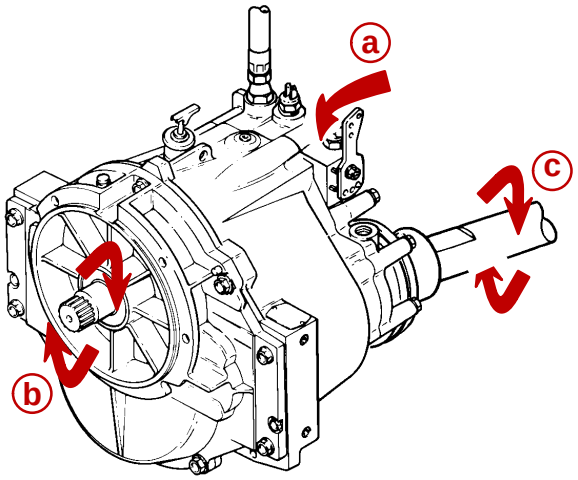
NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb-in.	lb-ft
Drain plug	33.8		25
Fluid hose to cooler			
Fluid hose to housing			
Transmission to flywheel housing	74.5		55
Rear mounts to transmission	61		45
Shift lever to valve	12	115	
Neutral start safety switch	12	115	
Propeller shaft coupler to output flange	67.7		50

Transmission / Propeller Rotation

These transmissions are full power reversing transmissions, allowing a standard (LH rotation) engine to be used for both propeller rotations. Propeller rotation (output shaft rotation) is determined by shift cable attachment at the remote control. Use correct rotation propeller and shift cable hook up for direction desired.

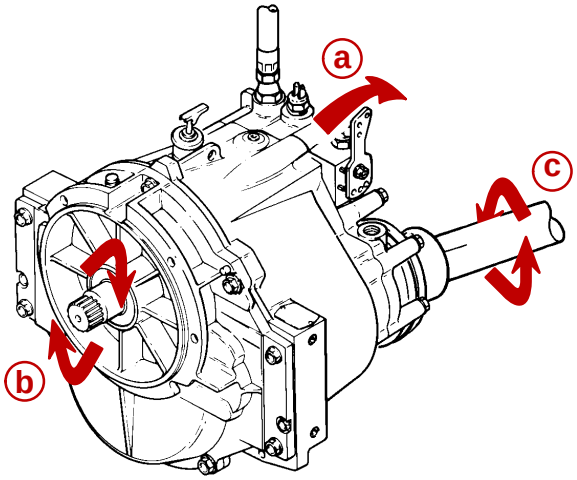
Transmission rotation is described when viewed from the rear of transmission with the transmission in the forward gear selector position.



71888

Typical

- **a -** Direction of shift lever engagement (toward flywheel)
- **b -** Engine/transmission input shaft shaft rotation direction (LH)
- **c -** Transmission output/propeller shaft rotation direction (LH)



71888

Typical

- **a -** Direction of shift lever engagement (away from flywheel)
- **b -** Engine/transmission input shaft rotation direction (LH)
- **c -** Transmission output/propeller shaft rotation direction (RH)

Fluid Level

Checking

⚠ WARNING

Do not remove the dipstick with the engine operating. Hot oil can cause burns.

⚠ CAUTION

Clean around the area of the dipstick before removing. Small particles of dirt can cause damage to internal components and cause the valves to stick.

WARM

NOTE: *Checking the transmission fluid level while warm requires 2 people as the level begins to rise within 2 seconds of stopping the engine. For convenience and to ensure accurate readings, it is recommended that a cold fluid full mark is made and the cold fluid procedure is followed.*

1. Loosen the dipstick by turning the T-handle COUNTERCLOCKWISE until it moves freely within the dipstick tube. Leave the handle inserted fully in the dipstick tube.
2. Start the engine and operate in NEUTRAL at 1500 rpm for 2 minutes.
3. Stop the engine.
4. Immediately remove the dipstick and wipe it clean.

IMPORTANT: Push the dipstick all the way down into the dipstick tube when checking fluid level.

5. Insert the dipstick fully into the transmission, withdraw it, and read the fluid level. Fluid level should be up to full mark. If low, add specified fluid through dipstick tube on transmissions.
   a. Allow approximately 15 seconds for the fluid to settle; insert the dipstick.
   b. Start the engine and operate for 60 seconds. Shut engine off.
   c. Repeat steps 2.-5. until correct fluid level is obtained.

COLD

NOTE: Cold Fluid Level Check: *Checking the fluid level before starting the engine is the preferred method to assure correct operating level. The dipstick should be marked or scribed with a cold level mark.*

1. Follow the procedure for the warm fluid level check to ensure the transmission is full and then allow the boat to sit overnight.

IMPORTANT: Push the dipstick all the way down into the dipstick tube when checking the fluid level.

2. Remove the dipstick, wipe clean, and reinsert.
3. Remove the dipstick, observe the fluid level, and mark the cold fluid level.
4. Reinstall the dipstick and tighten the T-handle securely. Do not overtighten.
5. Future checks can be made when the transmission fluid is cold:
   a. Remove the dipstick and wipe it clean.
   b. Reinsert the dipstick and remove to observe the fluid level.

Refer to **Section 1B - Maintenance**.

Changing

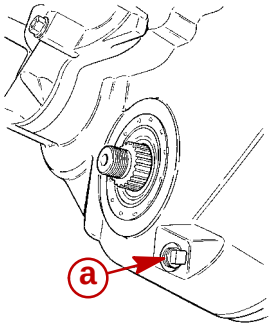
IMPORTANT: Do not start or crank the engine without fluid in the transmission.

Transmission fluid should be changed when servicing the transmission.

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

1. Clean area around drain plug.
2. Remove the dipstick.
3. Remove the drain plug.



73252

a - Drain plug

4. Drain the oil from the transmission into a suitable container.
5. Check the oil for the following foreign matter:

- **Metal Particles -** A few small particles are normal. Larger metal chips are an early sign of transmission failure which may mean the transmission should be disassembled and inspected for internal damage.
- **Rubber Particles -** Indication of cooler hose wear. The hoses should be inspected for cracks or fraying. Replace the damaged hoses.
- **External Debris -** Examples of external debris include sea weed and eel grass.

6. Coat the drain plug threads with sealant. Install and torque the drain plug.

Description	Where Used	Part Number
Perfect Seal	Drain plug threads	92-34227-1

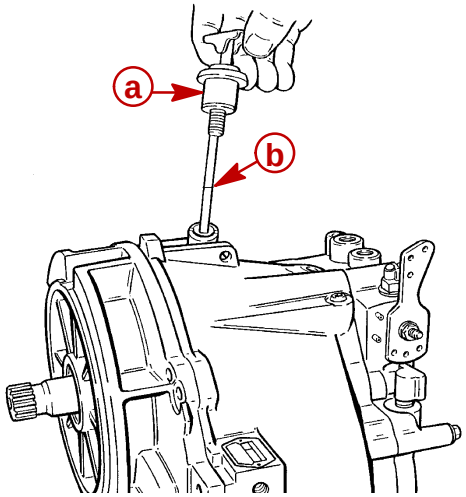
Description	Nm	lb-in.	lb-ft
Drain plug	33.8		25

7. Fill the transmission with specified fluid.

Filling

IMPORTANT: Use only specified transmission fluid.

1. Remove the dipstick.
2. Fill the transmission with fluid through the dipstick tube to bring the level up to the full mark.



73250

a - Dipstick
b - Dipstick tube

3. Replace the dipstick.

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

IMPORTANT: To accurately check the fluid level, operate the engine at 1500 rpm for 2 minutes immediately prior to checking the fluid level.

4. Start the engine and operate at 1500 rpm for 2 minutes to fill all hydraulic circuits.

IMPORTANT: Push the dipstick all the way down into the dipstick tube when checking the fluid level.

5. Stop the engine and quickly check the fluid level. Add transmission fluid, if necessary, to bring the level up to the full mark on the dipstick.
6. Reinstall the dipstick and tighten the T-handle securely. Do not overtighten.

Removal

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

NOTICE

The following procedure describes removal of the transmission without removing the engine. If the engine must be removed, refer to Section 2.

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect both battery cables.
2. Drain the transmission fluid.
3. Disconnect the fluid cooler hoses.

NOTE: *Fluid cooler should be removed with transmission.*

4. Disconnect the shift cable from the transmission.
5. Disconnect the wires from the neutral start safety switch.
6. Disconnect the wires from the transmission fluid temperature switch.
7. Loosen the trunnion clamping fasteners on the engine mounts (port and starboard).
8. Remove the coupling nuts and bolts and separate the propeller shaft flange from the transmission output flange.
9. Remove the 4 rear engine mount to engine bed fasteners and hardware.
10. Support the rear part of the engine with a hoist or put wooden blocks under the flywheel housing.

11. Support the transmission with a hoist or by other suitable means through the lifting eye on the transmission case.
12. Remove the port and starboard rear mount brackets (with base and trunnion) from the transmission.

⚠ CAUTION

Avoid damage to transmission input shaft or engine coupler. Ensure that the transmission is completely supported before removing hardware attaching transmission to flywheel housing.

13. Remove all hardware attaching the transmission to the flywheel housing.
14. Pull the transmission straight back and away from the engine to completely disengage the splines on the input shaft.
15. Carefully lift out the transmission.

Installation

1. Check the transmission output shaft rolling torque.
2. Apply lubricant to the transmission input shaft splines and engine drive plate splines.

Description	Where Used	Part Number
Engine Coupler Spline Grease	Transmission input shaft splines and engine drive plate splines	92-802869A1

3. Using a suitable hoist, position the transmission in the boat and align the transmission input shaft splines with the engine drive plate splines.
4. Slide the transmission into place and secure with attaching hardware. Torque the transmission to flywheel housing fasteners.

Description	Nm	lb-in.	lb-ft
Transmission to flywheel housing fasteners	74.5		55

5. Remove the hoist.
6. Install the rear mount brackets to the transmission. Torque the fasteners and hardware.

Description	Nm	lb-in.	lb-ft
Rear mounts to transmission fasteners and hardware	61		45

7. Using hoist, raise engine and transmission to remove blocks (if used).
8. Lower the assembly to the engine bed.
9. Securely tighten the 4 rear engine mount to engine bed fasteners and hardware.
10. Relieve the hoist tension.
11. Connect the wires to the neutral start safety switch.
12. Connect the wires to the transmission fluid temperature switch.
13. Connect the fluid cooler water hoses and tighten the hose clamps securely.

⚠ CAUTION

Improper shift cable connection and adjustment can cause premature clutch failure.

14. Connect and adjust the shift cables.
15. Check the engine final alignment. Refer to **Section 2**.
16. After the engine has been properly aligned, connect the propeller shaft coupler to the transmission output flange with bolts, lockwashers and nuts. Torque the fasteners.

Description	Nm	lb-in.	lb-ft
Propeller shaft coupler to output flange fasteners	67.7		50

17. Torque the trunnion clamping fasteners on the engine mounts (port and starboard) that were loosened during removal.

IMPORTANT: All coupler bolts must be Metric Grade 10.9 (SAE Grade 8) or better, with a shoulder (grip length) long enough to pass through the face mating plane of couplers.

18. Install the transmission fluid cooler and hoses. Torque hose fittings at cooler and transmission housing.

Description	Nm	lb-in.	lb-ft
Fluid hose to housing hose fittings	33.8		25

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

19. Refill the transmission with specified fluid.
20. Connect both battery cables. Tighten the clamp securely.
21. Start the engine and check for leaks.
22. Check the fluid level.

Shift Lever Installation

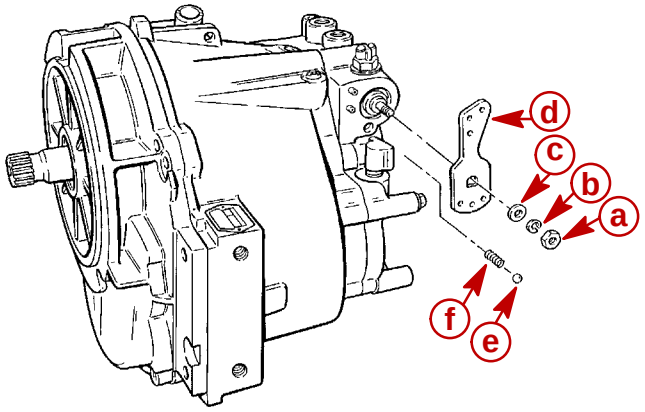
IMPORTANT: The Velvet Drive Warranty is jeopardized if the shift lever poppet spring and/or ball is permanently removed, or if the shift lever is changed, repositioned or if the linkage between the remote control and the transmission shift lever does not have sufficient travel in both directions.

The shift lever and the related parts must be assembled correctly.

1. Lubricate the poppet ball, spring and holes in the shift lever.

Description	Where Used	Part Number
2-4-C with Teflon	Transmission shift lever poppet ball, spring, and holes	92-802859A1

2. Install the poppet spring and ball. Retain the ball by placing the shift lever on the shaft.
3. Install the flat washer, lockwasher, and nut on the shaft.
4. Torque the nut.



73251

Typical shift lever

- **a** - Nut
- **b** - Lockwasher
- **c** - Flat washer
- **d** - Shift lever
- **e** - Poppet ball
- **f** - Poppet spring

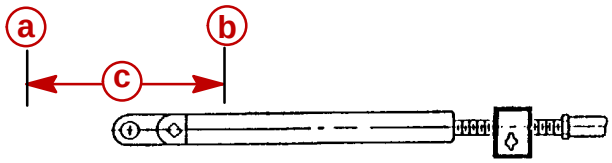
Description	Nm	lb-in.	lb-ft
Shift lever to valve nut	12	115	

5. After installation, move the shift lever through the FORWARD, NEUTRAL and REVERSE positions. No more than finger-tip effort should be required. If the valve binds, the cause for binding must be found and corrected.

Shift Control And Cables

IMPORTANT: The Velvet Drive Warranty is jeopardized if the shift lever poppet ball or the spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if the remote control and the shift cable do not position the shift lever correctly.

The remote control also must provide a total shift cable travel (at the transmission) of at least 70 mm (2-3/4 in.) to position transmission shift lever fully in the Position A and Position B gear positions. Insufficient shift cable travel will cause the transmission to slip and eventually fail.



72602

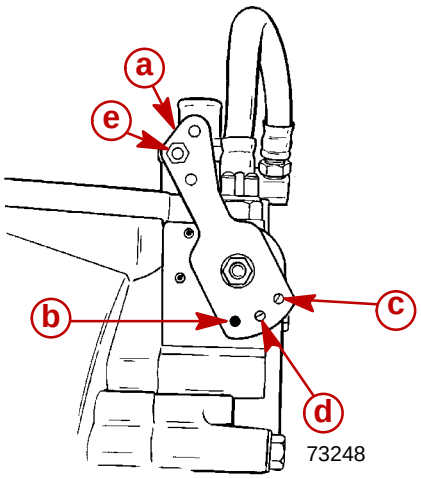
a - Position A
b - Position B
c - Shift cable travel

Description	Specification
Shift cable travel	70 mm (2-3/4 in.)

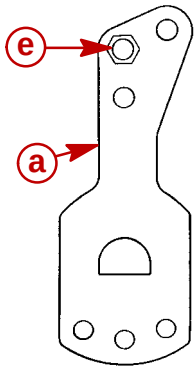
Transmission Shift Lever and Shift Cable Bracket

IMPORTANT: The Velvet Drive Warranty is jeopardized if the shift lever poppet ball or the spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if the remote control and the shift cable do not position the shift lever correctly.

The lever has 3 holes. The shift lever stud is placed in the forward-middle hole when using Quicksilver remote control cables.



73248

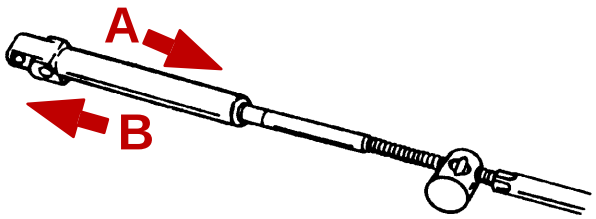


73249

- **a** - Transmission shift lever
- **b** - Poppet ball must be centered in this detent hole when LEFT-HAND propeller shaft rotation is desired
- **c** - Poppet ball must be centered in this detent hole when RIGHT-HAND propeller shaft rotation is desired
- **d** - Poppet ball must be centered in this detent hole for NEUTRAL position
- **e** - Shift lever stud location (for Quicksilver shift cables)

For LEFT-HAND Propeller Shaft Rotation, shift cable hookup at remote control must result in shift cable end guide moving in direction "**A**" when remote control handle is placed in FORWARD position.

For RIGHT-HAND Propeller Shaft Rotation, shift cable hookup at remote control must result in shift cable end guide moving in direction "**B**" when remote control handle is placed in FORWARD position.

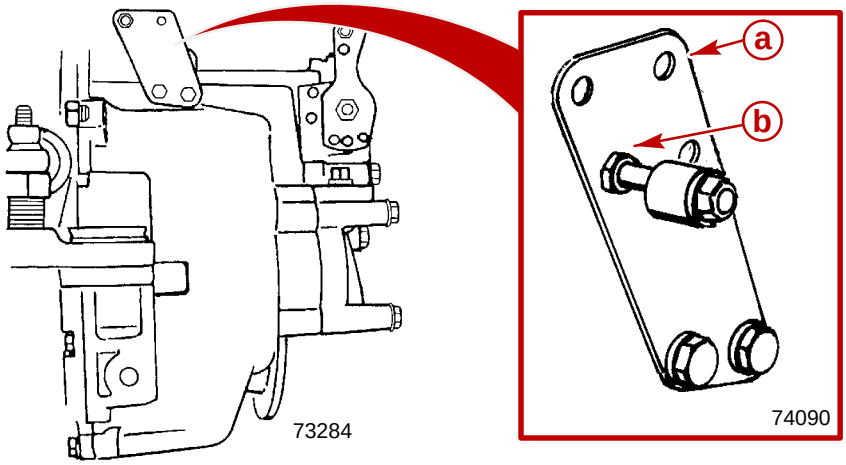


23242

⚠ WARNING

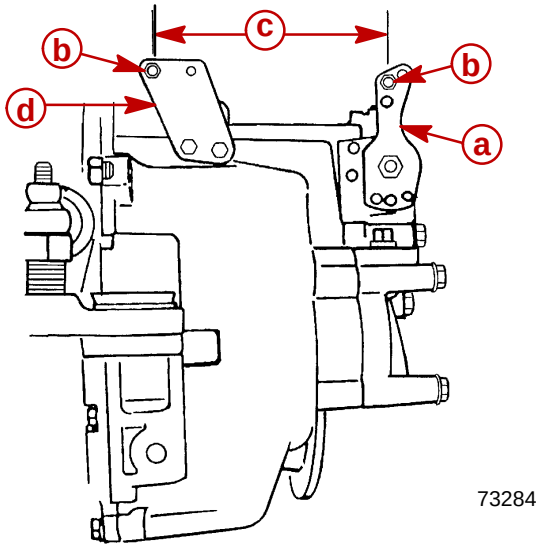
Avoid serious personal injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole when using bracket with 4 anchor location holes.

IMPORTANT: Ensure that the anchor stud is installed in the front hole as shown in the illustration following.



a - Shift cable bracket
b - Anchor stud in front hole (for Quicksilver shift cables)

IMPORTANT: The distance between the anchor studs in the shift lever and the shift cable bracket must be 181 mm (7-1/8 in.).



a - Shift lever
b - Anchor stud
c - Distance between anchor studs
d - Shift cable bracket

Description	Specification
Distance between shift lever and shift cable bracket anchor studs	181 mm (7-1/8 in.)

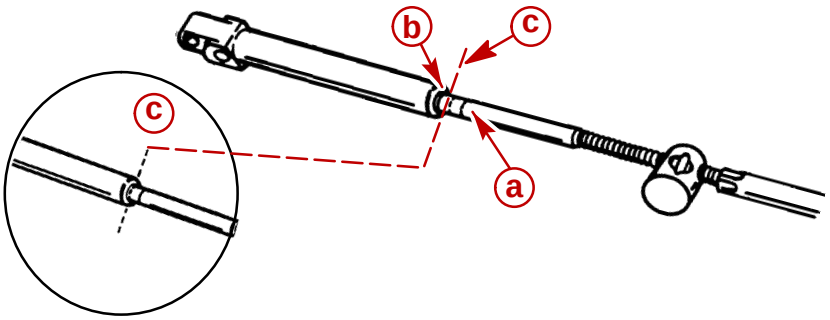
Installation and Adjustment

IMPORTANT: When installing shift cables, route to avoid sharp bends and/or contact with moving parts. Do not fasten any items to shift cables.

NOTE: *On models with other than Quicksilver shift cables, refer to the shift cable manufacturer's instructions.*

IMPORTANT: The Velvet Drive Warranty is jeopardized if the shift lever poppet ball or the spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if the remote control and the shift cable do not position the shift lever correctly.

1. Place the remote control shift lever and the transmission shift lever in the NEUTRAL position.
2. Remove the nuts and the washers from the shift cable attaching studs.
3. Locate the center of the remote control and the control shift cable play (backlash) as follows:
   a. Ensure that the remote control is in the NEUTRAL position.
   b. Push in on the control cable end with enough pressure to remove the play and mark position "**a**" on the tube.
   c. Pull out on the control cable end with enough pressure to remove the play and mark position "**b**" on the tube.
   d. Measure the distance between marks "**a**" and "**b**," and mark position "**c**," halfway between marks "**a**" and "**b**."



72603

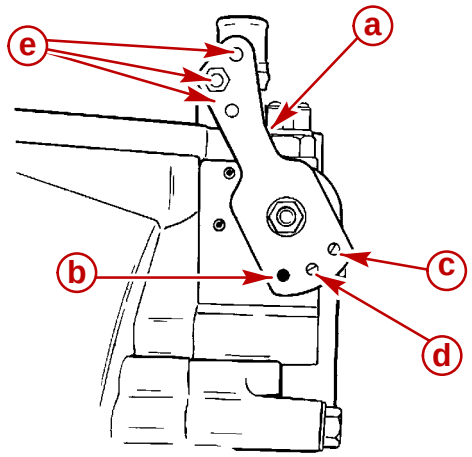
4. Center the cable-end play, then adjust the cable barrel to align the holes in the barrel and in the cable end guide, with the attaching points on the transmission.
5. Install the shift cable. Temporarily, do not secure.

IMPORTANT: Transmission is fully in gear when poppet ball is positioned in lever detent hole in either direction.

⚠ CAUTION

Remote control and shift cable must position transmission shift lever exactly as shown, or transmission failure may occur. Do not remove poppet ball or spring.

6. Place remote control shift lever in gear and check position of transmission shift lever. Shift lever must be positioned correctly.
7. Place remote control shift lever in opposite gear position and again check transmission shift lever position. Shift lever must be positioned correctly.
8. If the transmission shift lever will position properly in one gear, but not in the other gear, recheck the shift cable adjustment. If the transmission shift lever will not position properly in either gear, move the transmission shift lever stud from the top hole in the shift lever to the bottom hole and recheck for proper positioning. If proper positioning is still not obtained, the remote control does not provide sufficient shift cable travel and must be replaced.



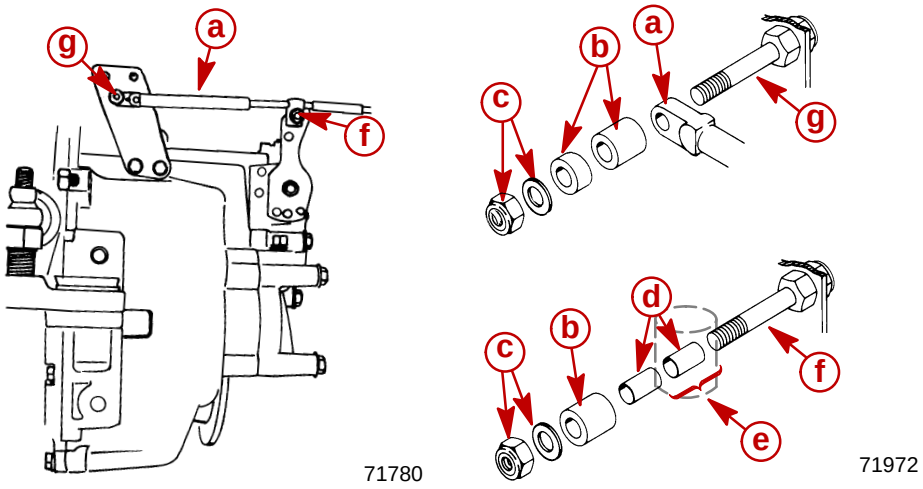
73248

a - Transmission shift lever
b - Poppet ball must be centered in this detent hole for LEFT-HAND propeller shaft rotation
c - Poppet ball must be centered in this detent hole for RIGHT-HAND propeller shaft rotation
d - Poppet ball must be centered in this detent hole for NEUTRAL position
e - Shift lever stud hole for Quicksilver shift cables

NOTE: *Move the shift lever stud to lower hole if necessary, to center the poppet ball in the FORWARD and REVERSE detent holes.*

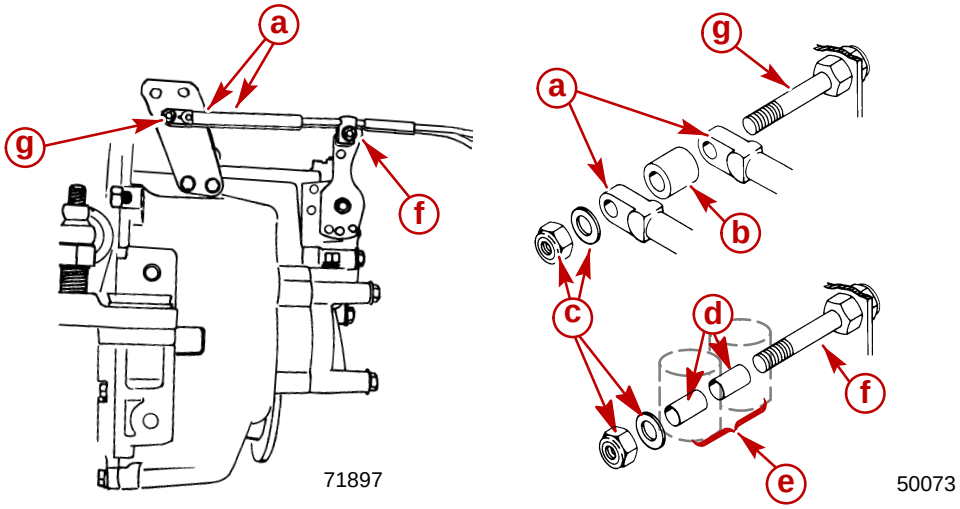
9. Install the nut and washer to the cable end guide stud. Tighten until the nut contacts, then loosen 1/2 turn.

10. Install the nut and the washer to the cable barrel stud. Tighten until the nut contacts. Tighten securely, but do not overtighten.



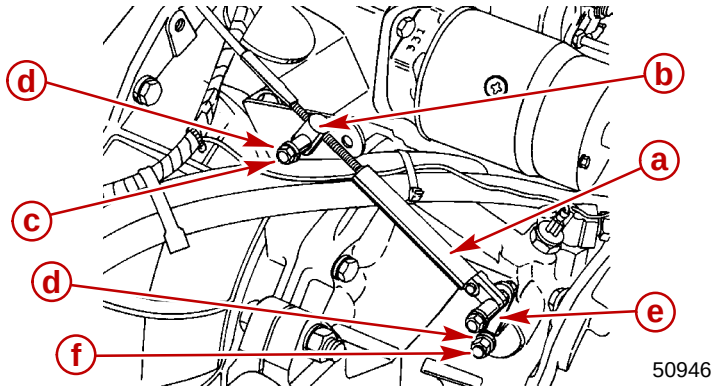
Typical single cable installation - rear approach

- **a** - Cable end guide
- **b** - Spacer (as required)
- **c** - Elastic stop nut and washer
- **d** - Bushings
- **e** - Cable barrels [positions only indicated in right drawing]
- **f** - Cable barrel stud
- **g** - Cable end guide stud

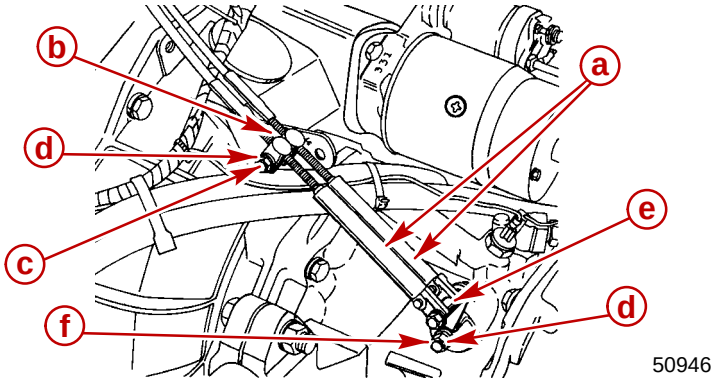


Typical dual cable installation - rear approach

- **a** - Cable end guide
- **b** - Spacer (as required)
- **c** - Elastic stop nut and washer
- **d** - Bushings
- **e** - Cable barrels [positions only indicated in right drawing]
- **f** - Cable barrel stud
- **g** - Cable end guide stud



Typical Single cable installation - front approach

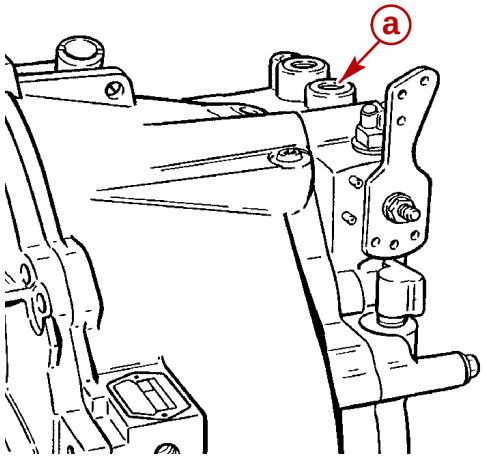


Typical dual cable installation - front approach

- **a** - Cable end guide
- **b** - Cable barrel
- **c** - Cable barrel stud
- **d** - Elastic stop nut and washer
- **e** - Spacer
- **f** - Cable end guide stud

Pressure Test

1. Remove the temperature switch.
2. Install the pressure gauge in the main line pressure tap.



73247

a - Main line pressure tap

3. With the boat in the water, start the engine and operate until the normal operating temperature is reached.
4. Check pressure readings.

Engine rpm	Neutral Gear kPa (psi)		Forward Gear or Reverse Gear kPa (psi)	
	Minimum	Maximum	Minimum	Maximum
900	69 (10)	345 (50)	1724 (250)	2758 (400)
2400	103 (15)	483 (70)		
4500	–	–		

Transmission Repair

Mercury Marine does not stock or sell replacement parts for these transmissions. Velvet Drive has a network of distributors throughout the world to service their product. These distributors, in turn, have a dealer network to service the transmissions. Also, service manuals for each transmission can be obtained from Velvet Drive.

For the location of your closest distributor or service literature contact:

Velvet Drive Transmissions
1208 Old Norris Road
Liberty, SC 29657
U.S.A.
Phone: 864-843-9234
Fax: 864-843-1276
Email: administration@velvetdrive.com

NOTES:

DRIVES

Section 8C - ZF Marine / Hurth Down Angle and V-drive Transmission

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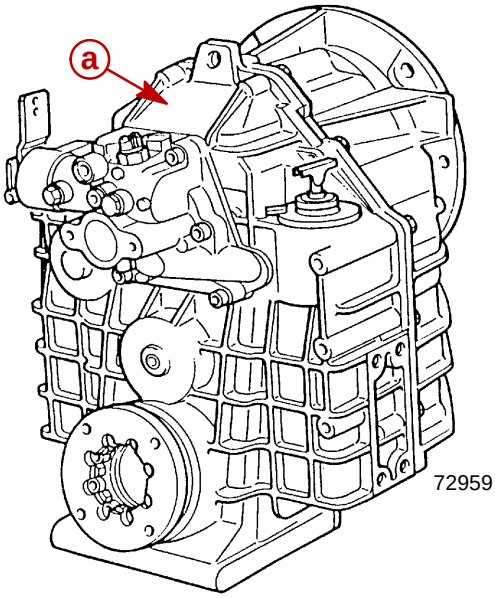
8C

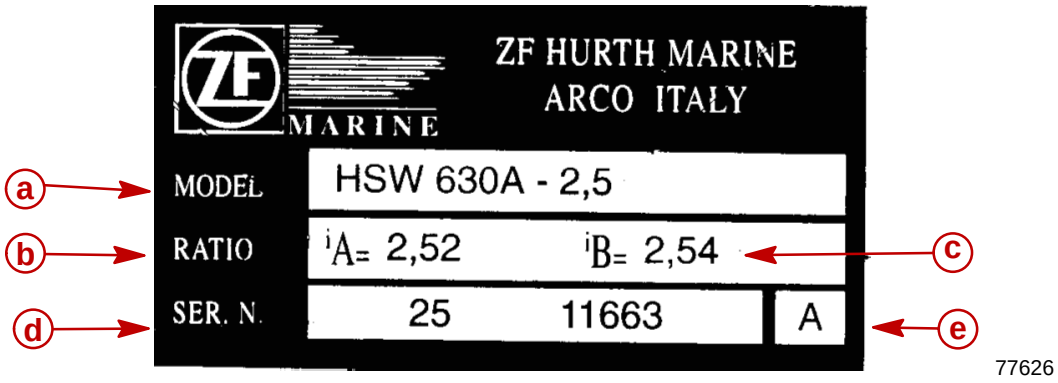
Identification

The transmission identification plate is located on the top rear of the transmission.



ZF Marine 63A/ Hurth 630A

a - Identification location



Typical ZF Marine / Hurth transmission identification plate

a - Transmission type
b - Gear ratio with shifting position “A”
c - Gear ratio with shifting position “B”
d - Serial number
e - Year progressive letter

Specifications

Operating Specifications

Description	Specification	
Shifting pressure	21.5-23.5 bar (312-341 psi)	
Operating temperature	54-79 degrees C (130-175 degrees F)	
Temperature switch settings +/– 10 degrees	Open	Close
	87.8 degrees C (190 degrees F)	110 degrees C (230 degrees F)

Ratios and Part Numbers

NOTE: *The ratio is shown on the identification plate. The ratio may be rounded off in some cases.*

63A/630A

Ratio (Normal)	ZF Marine Model Number	Hurth Model Number	Mercury Marine Part Number
1.5:1	63A	630A	863744T2
2.0:1			863744T3
2.5:1			863744T4
2.7:1			863744T5

63IV/630V

Ratio (Normal)	ZF Marine Model Number	Hurth Model Number	Mercury Marine Part Number
1.55:1	63IV	630V	863745T2
2.0:1			863745T3
2.5:1			863745T4

80A/800A

Ratio (Normal)	ZF Marine Model Number	Hurth Model Number	Mercury Marine Part Number
2.85:1	80	80A	806730A1

Fluid Specifications

NOTICE
Unit Of Measurement: liters (U.S. quarts) **All capacities are approximate fluid measures.**

NOTE: *Always use the dipstick to determine the exact fluid level.*

Model	Capacity	Fluid Type
63A/630A	4.0 (4-1/2)	Dexron III Automatic Transmission Fluid
63IV/630V	4.0 (4-1/2)	

Pressure Specifications

Engine rpm	Shifting Pressure	
	Position A	Position B
2000	21.5-23.5 bar (312-341 psi)	21.5-23.5 bar (312-341 psi)

Special Tools

Description	Part Number
Thermometer [(3/8-NPT, thread 18 to 132 degrees C (0 - 270 degrees F)	Obtain locally
Pressure gauge (0-500 psi), (3/8-NPT)	

Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Engine Coupler Spine Grease	Transmission input shaft splines	92-802869A1
Liquid Neoprene	Connections on neutral safety switch	92-25711--3
Loctite 242	Transmission bracket retention bolts	92-809821

Equivalent products may be used.

Precautions

Transmission gear ratio is marked on transmission identification plate, which is located on the top of transmission. Transmission rotation is described when viewed from the rear of transmission.

- Do not start or crank engine without fluid in transmission.
- Except in an emergency, never shift transmission at engine speeds above 1000 rpm.
- Free wheeling of one propeller (in a twin engine boat) at trolling speeds will not cause damage to the transmission; however, boat operation above trolling speed should be avoided. Ensure that proper fluid level exists before free wheeling propeller.
- Always replace oil cooler and hoses after a transmission failure or prior to installing a new or rebuilt transmission. Metallic particles from a failure tend to collect in the cooler and hoses and will gradually flow back into the fluid system and damage transmission.
- Always use specified oil cooler, hoses and fittings.

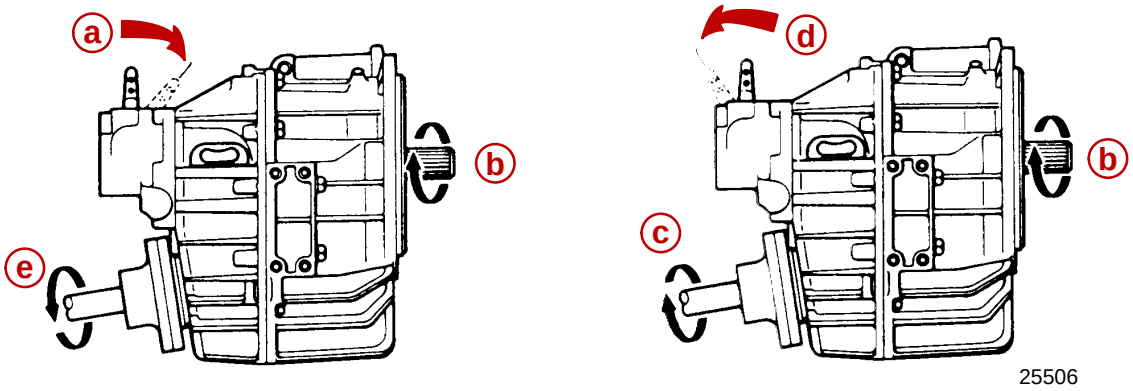
Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

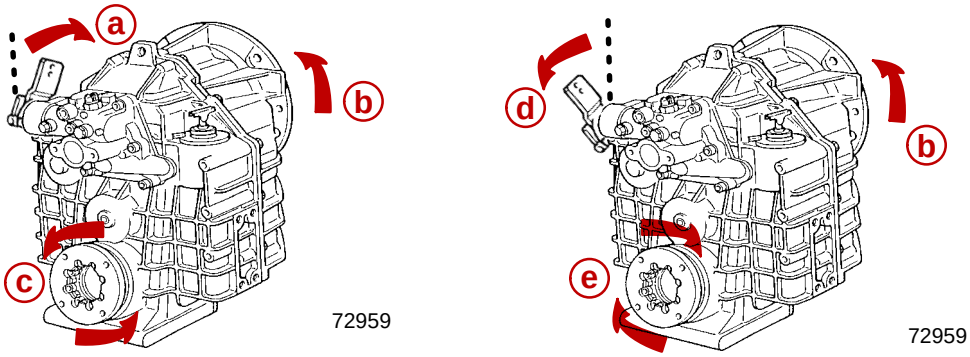
Description	Nm	lb-in.	lb-ft
Transmission to flywheel housing	61		45
Rear mount brackets	61		45
Coupler to output flange	67.7		50
Hose fittings at fluid cooler	33.8		25

Transmission / Propeller Rotation

These ZF Marine/Hurth Down Angle transmissions are full power reversing transmissions, allowing a standard LH rotation engine to be used for both propeller rotations. Propeller rotation is determined by shift cable attachment at the remote control. Use correct rotation propeller and shift cable hook up for direction desired.



ZF Marine/Hurth 63A/630A - 8 degree Down Angle transmissions



ZF Marine/Hurth 63IV/630V - V-drive transmissions

- **a** - Direction of shift lever engagement (toward flywheel)
- **b** - Engine/transmission input shaft rotation direction (LH)
- **c** - Transmission output/propeller shaft rotation direction (LH)
- **d** - Direction of shift lever engagement (away from flywheel)
- **e** - Transmission output/propeller shaft rotation direction (RH)

Fluid Level

IMPORTANT: Do not screw dipstick in; press it firmly in and remove to obtain an accurate reading. If dipstick and dipstick tube are threaded, do not damage threads.

Checking

IMPORTANT: Always check fluid level before operating transmission.

1. Loosen dipstick by turning the T-handle COUNTERCLOCKWISE.
2. Remove the dipstick and wipe it clean.
3. Insert the dipstick in the dipstick tube; do not screw it in.
4. Remove the dipstick and check fluid level.
5. If fluid is below top (full) line, add specified fluid through dipstick tube. Do not overfill. Reinstall dipstick with cap fully seated.

Changing

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

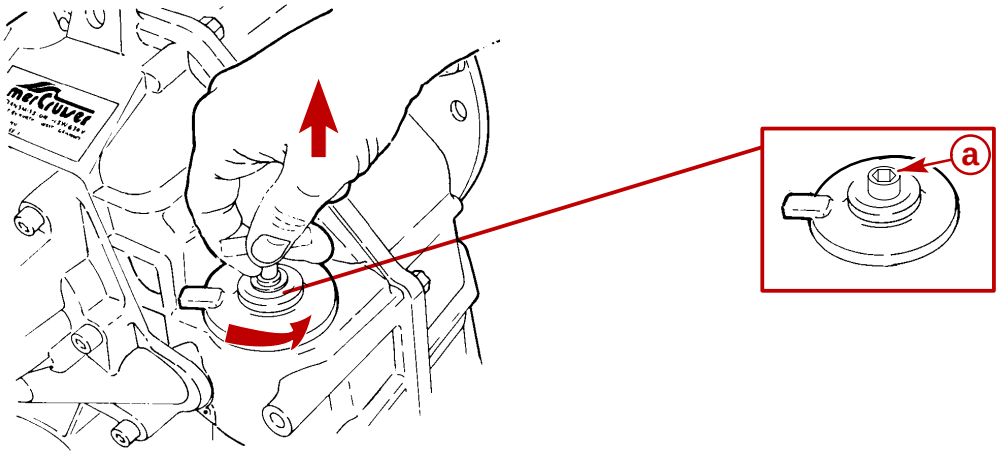
Transmission fluid should be changed when servicing the transmission.

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

1. Clean the exterior of transmission before disassembly.

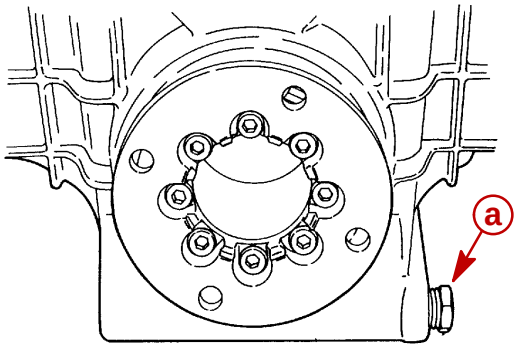
2. Using an allen wrench on the set screw, remove the oil filter from the housing by turning counterclockwise and pulling up at the same time.



27666

a - Set screw

3. **63IV/630V Only:** Remove drain plug from transmission and allow fluid to drain.



73013

a - Drain plug

a. Reinstall drain plug and tighten securely.

4. **63A/630A only:** Suction fluid out through filter tube.
5. Check the oil for the following foreign matter:

- **Metal particles -** A few small particles are normal. Larger metal chips are an early sign of transmission failure which may mean the transmission should be disassembled and inspected for internal damage.
- **Rubber particles -** Indication of cooler hose wear. The hoses should be inspected for cracks or fraying. Replace the damaged hoses.
- **External Debris -** Examples of external debris include sea weed and eel grass.

6. Fill the transmission with specified fluid.

Filling

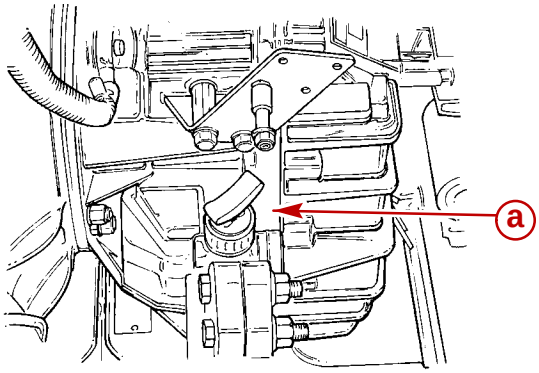
IMPORTANT: Use only specified transmission fluid.

IMPORTANT: The fluid level dipstick is located on the port side of transmission.

1. Remove dipstick.
2. Fill the transmission with fluid through the dipstick tube to bring the level up to the full mark.

IMPORTANT: Do not screw dipstick in; press it firmly in and remove to obtain an accurate reading. If dipstick and dipstick tube are threaded, do not damage threads.

3. Replace the dipstick.



77564

a - Dipstick tube

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

IMPORTANT: To accurately check the fluid level, operate the engine at 1500 rpm for 2 minutes immediately prior to checking the fluid level.

4. Start the engine and operate at 1500 rpm for 2 minutes to fill all hydraulic circuits.

IMPORTANT: Do not screw dipstick in; press it firmly in and remove to obtain an accurate reading. If dipstick and dipstick tube are threaded, do not damage threads.

5. Stop the engine and quickly check the fluid level. Add transmission fluid, if necessary, to bring the level up to the full mark on the dipstick.

Removal

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

NOTICE

The following procedure describes removal of the transmission without removing the engine. If the engine must be removed, refer to SECTION 2.

⚠ WARNING

Avoid injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

1. Disconnect the battery cables from the battery.
2. Drain the transmission fluid.
3. Disconnect fluid cooler hoses.

NOTE: *Fluid cooler should be removed with transmission.*

4. Disconnect the shift cable from the transmission.
5. Disconnect the wires from the neutral start safety switch.
6. Disconnect the wires from the transmission fluid temperature switch.
7. Loosen the trunnion clamping fasteners on the engine mounts (port and starboard).
8. Remove the coupling nuts and bolts and separate the propeller shaft flange from the transmission output flange.
9. Remove the four rear engine mount-to-engine bed fasteners and hardware.
10. Support the rear part of the engine with a hoist or put wooden blocks under the flywheel housing.

11. Support the transmission with a hoist or by other suitable means through the lifting eye on the transmission case.
12. Remove the port and starboard rear mount brackets (with base and trunnion) from the transmission.

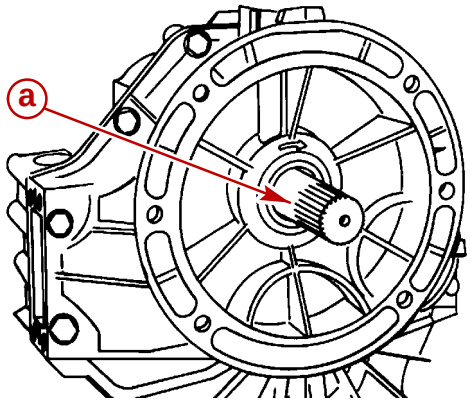
⚠ CAUTION

Avoid damage to transmission input shaft or engine coupler. Ensure that the transmission is completely supported before removing hardware attaching transmission to flywheel housing.

13. Remove all hardware attaching the transmission to the flywheel housing.
14. Pull the transmission straight back and away from the engine to completely disengage the splines on the input shaft.
15. Carefully lift out the transmission.

Installation

1. Check the transmission output shaft rolling torque.
2. Apply lubricant to the transmission input shaft splines and engine drive plate splines.



71044

a - Input shaft

Description	Where Used	Part Number
Engine Coupler Spine Grease	Transmission input shaft splines, engine drive plate splines	92-802869A1

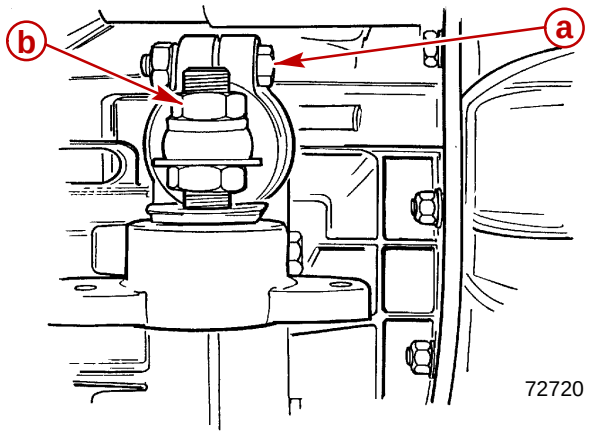
3. Using a suitable hoist, position the transmission in the boat and align the transmission splines with the drive plate splines.
4. Slide the transmission into place and secure with attaching hardware. Torque the transmission to flywheel housing fasteners.

Description	Nm	lb-in.	lb-ft
Transmission to flywheel housing	61		45

5. Remove the hoist.
6. Install the rear mount brackets to the transmission. Torque the fasteners and hardware.

Description	Nm	lb-in.	lb-ft
Rear mount brackets	61		45

7. Using hoist, raise engine and transmission to remove blocks (if used).
8. Lower the assembly to the engine bed.
9. Securely tighten the four rear engine mount-to-engine bed fasteners with hardware.

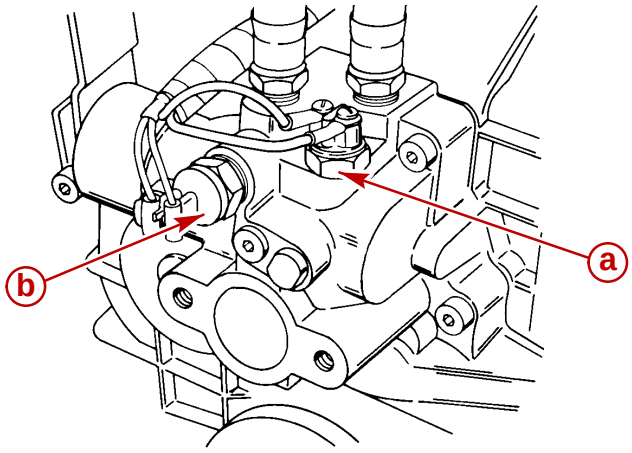


a - Bolts (4), 2 on each side
b - Locknuts (2), 1 on each side

10. Relieve the hoist tension.
11. Connect the wires to the neutral start safety switch, coat connections on the neutral start safety switch with sealant.

Description	Where Used	Part Number
Liquid Neoprene	Connections on neutral start safety switch	92-25711--3

12. Connect the wires to the audio warning temperature switch.



50686

a - Neutral safety switch
b - Audio warning temperature switch

13. Connect the fluid cooler hoses and tighten the hose clamps securely.

⚠ CAUTION

Improper shift cable connection and adjustment can cause premature clutch failure.

14. Connect and adjust shift cables.

15. Check engine final alignment. Refer to **Section 2B**.

IMPORTANT: All coupler bolts must be Metric Grade 10.9 (SAE Grade 8) or better, with a shoulder (grip length) long enough to pass through the face mating plane of couplers.

16. After the engine has been properly aligned, connect the propeller shaft coupler to the transmission output flange with bolts, lockwashers and nuts. Torque the fasteners.

Description	Nm	lb-in.	lb-ft
Propeller shaft coupler to output flange	67.7		50

17. Torque the trunnion clamping fasteners on the engine mounts (port and starboard) that were loosened during removal.

Description	Nm	lb-in.	lb-ft
Hose fittings at fluid cooler	33.8		25

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

18. Refill transmission with specified fluid.

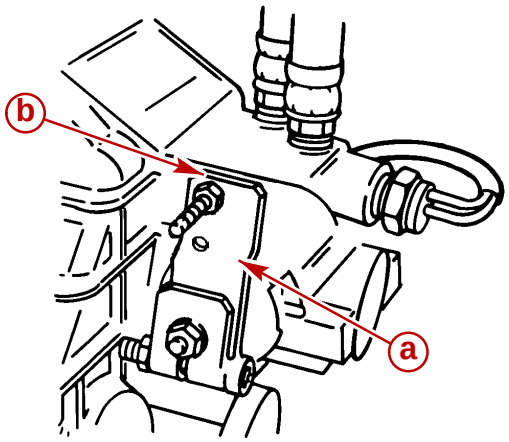
19. Connect negative battery cable. Tighten clamp securely.

20. Check for leaks and check fluid level after first engine start-up.

Shift Control And Cables

Transmission Shift Lever and Shift Cable Bracket

The shift lever has 2 holes. The shift cable anchor stud is installed in the top hole when using Quicksilver remote control cables.



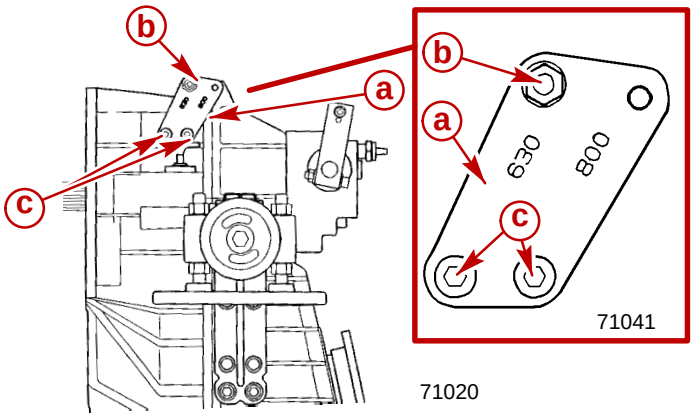
77520

a - Shift lever
b - Shift cable anchor stud location (for Quicksilver remote control cables)

⚠ WARNING

Avoid serious personal injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole when using bracket with two anchor location holes.

1. **On bracket with 2 anchor location holes,** install anchor stud in the correct hole for application.



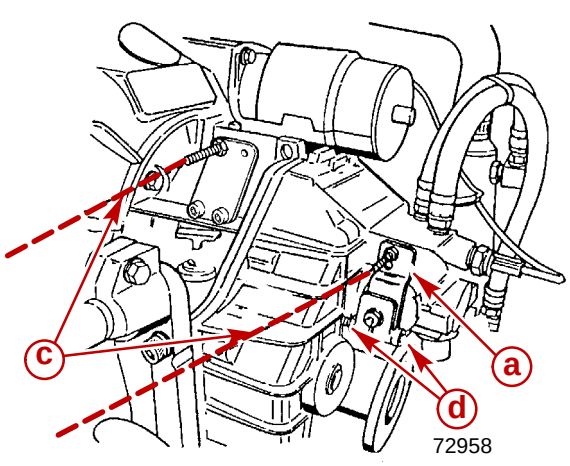
71041

71020

Shift cable bracket - anchor stud position shown for 63/630 transmission

a - Shift cable bracket
b - Shift cable anchor stud
c - Bracket fasteners

IMPORTANT: Ensure that shift lever is positioned approximately 10 degrees aft of vertical when in the neutral detent position. The distance between the anchor studs in the shift lever and the shift cable bracket must be 181 mm (7-1/8 in.). If necessary, loosen clamping bolt and position lever so that the distance between the studs is as specified when in the NEUTRAL detent position, and retighten clamping bolt.



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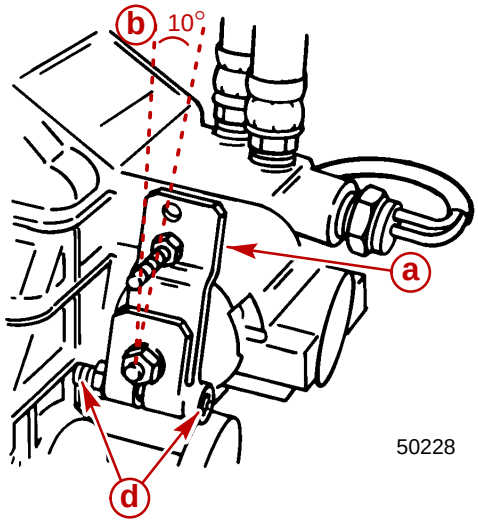


50228

Typical ZF Marine /Hurth transmission shown

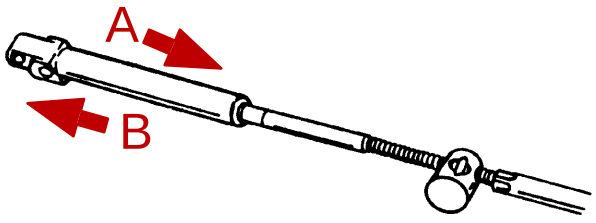
- **a** - Shift lever
- **b** - Shift lever in NEUTRAL detent
- **c** - Distance between anchor studs
- **d** - Clamping bolt

Description	Specification
Distance between shift lever and shift cable bracket anchor studs	181 mm (7-1/8 in.)

IMPORTANT: Transmission propeller rotation is determined by the shift cable installation in the remote control.

For right-hand propeller rotation - Control cable will have to be installed in remote control so that cable end will move in direction "**A**" when shift handle is placed in the forward position.

For left-hand propeller rotation - Control cable will have to be installed in remote control so that cable end will move in direction "**B**" when shift handle is placed in the forward position.



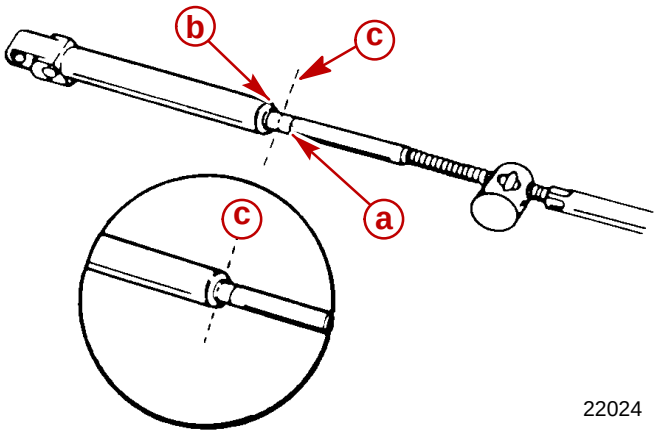
23242

Installation and Adjustment

IMPORTANT: When installing shift cables, ensure that cables are routed to avoid sharp bends and/or contact with moving parts. Do not fasten any items to shift cables.

NOTE: *On models with other than Quicksilver shift cables refer to the shift cable manufacturer's instructions.*

1. Place remote control shift lever and transmission shift lever in neutral position.
2. Remove nuts and washers from shift cable attaching studs.
3. Locate center of remote control and control shift cable play (backlash), as follows:
   a. Ensure that remote control is in NEUTRAL position.
   b. Push in on control cable end with enough pressure to remove play; mark position "**a**" on tube.
   c. Pull out on control cable end with enough effort to remove play; mark position "**b**" on tube.
   d. Measure distance between marks "**a**" and "**b**," and mark position "**c**" halfway between marks "**a**" and "**b**."

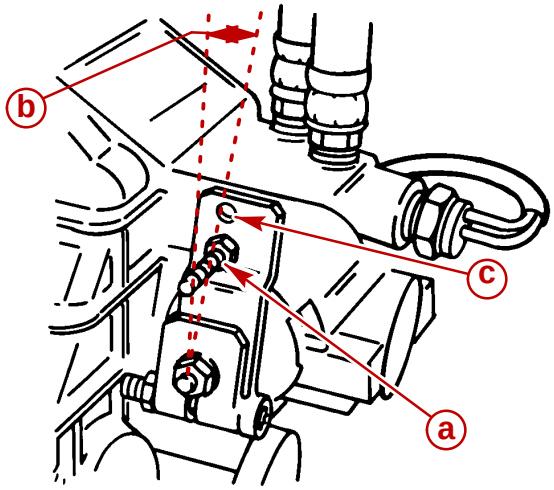


22024

4. Center cable-end play, then adjust cable barrel to align holes in barrel and in cable end guide with attaching points on transmission.
5. Temporarily install shift cable. Do not secure at this time.

IMPORTANT: Transmission is fully in gear when shift lever comes to a stop, in either direction.

6. Place remote control shift lever in FORWARD gear position. Ensure transmission is fully in gear, as follows:
   a. Hold shift lever in position.
   b. Carefully slide shift cable off of anchor points.
   c. Attempt to move shift lever further.
7. Place remote control shift lever in REVERSE gear position. Ensure transmission is fully in gear as follows:
   a. Hold shift lever in position.
   b. Carefully slide shift cable off of anchor points.
   c. Attempt to move shift lever further.
8. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in either gear, move transmission shift lever stud from top hole in shift lever to bottom hole and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.

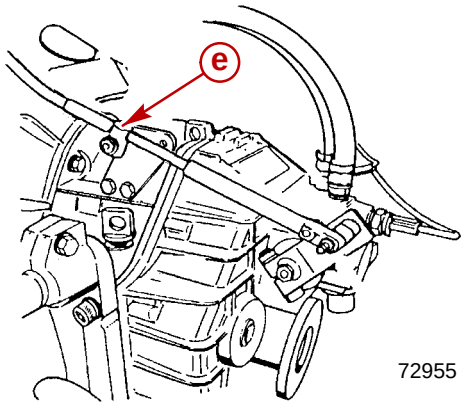


50228

a - Shift lever stud (in bottom hole, if required)
b - Lever, in neutral detent, must be approximately 10 degrees of vertical
c - Shift lever top hole

9. Install nut and washer to cable end guide stud. Tighten until the nuts contact, then loosen 1/2 turn.
10. Install nut and washer to cable barrel stud. Tighten until the nuts contact, then loosen 1/2 turn.

NOTE: *To change cable approach direction on single or dual station installations, only the spacer/bushings have to be switched to the opposite stud. The studs are identical.*



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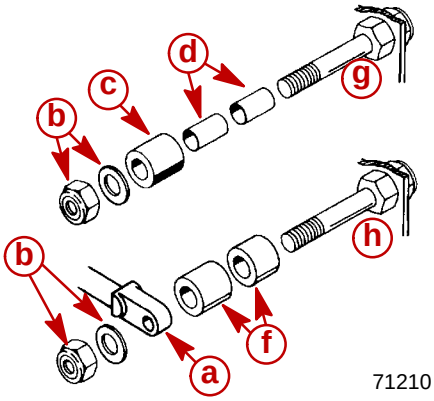
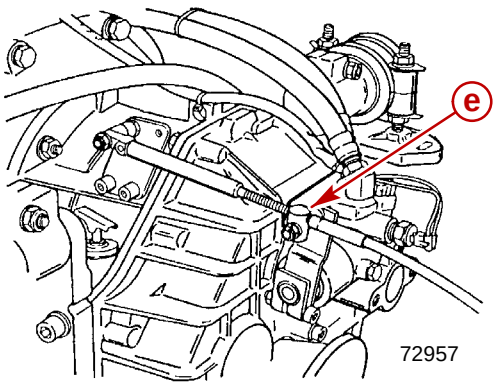


71210

Typical single cable installation - forward approach

- **a** - Cable end guide
- **b** - Locknut and washer
- **c** - Spacer (fits over bushings)
- **d** - Bushing
- **e** - Cable barrel
- **f** - Spacers (fits over stud)
- **g** - Cable barrel stud
- **h** - Cable end guide stud



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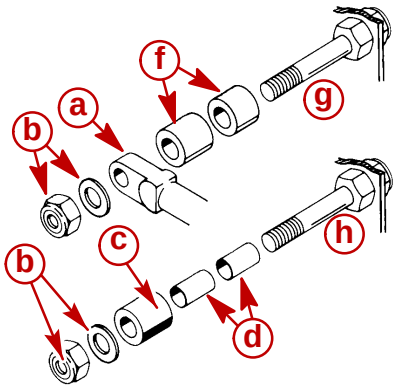
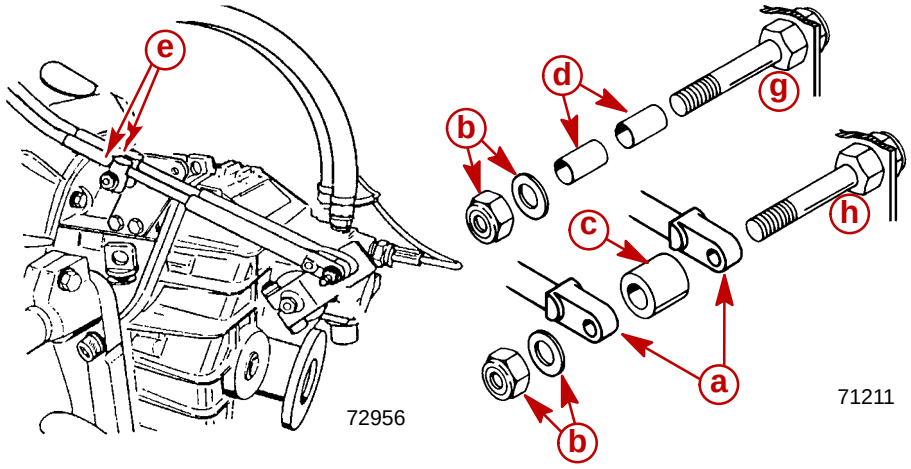


50229

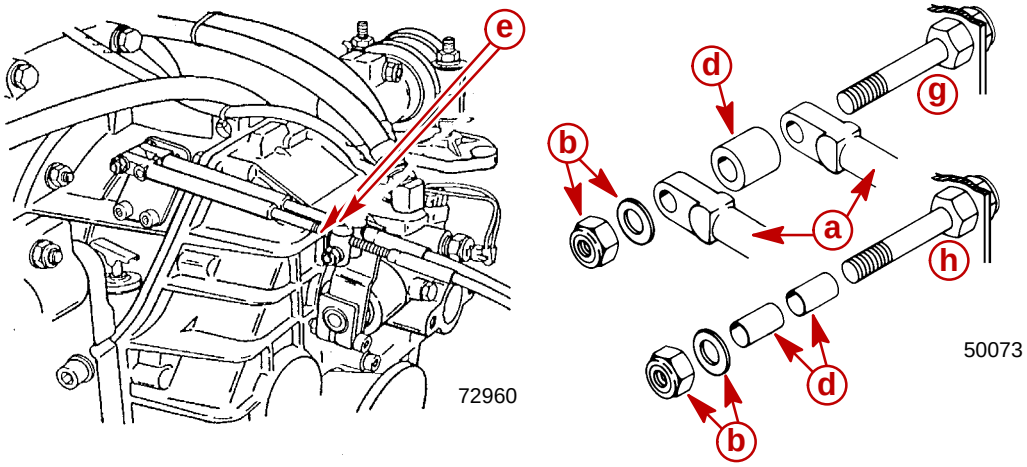
Typical single cable installation - rear approach

- **a** - Cable end guide
- **b** - Locknut and washer
- **c** - Spacer (fits over bushings)
- **d** - Bushing
- **e** - Cable barrel
- **f** - Spacers (fits over stud)
- **g** - Cable barrel stud
- **h** - Cable end guide stud



Typical dual cable installation - forward approach

a - Cable end guide
a - Cable end guide
b - Locknut and washer
c - Spacer (fits over bushings)
d - Bushing
e - Cable barrel
f - Spacers (fits over stud)
g - Cable barrel stud
h - Cable end guide stud

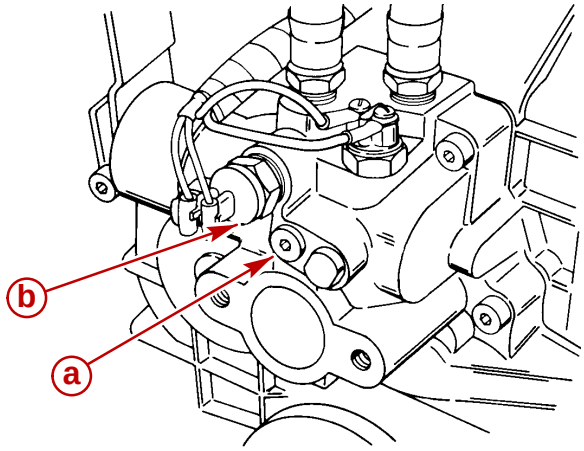


Typical dual cable installation - rear approach

a - Cable end guide
b - Locknut and washer
c - Spacer (fits over bushings)
d - Bushing
e - Cable barrel
f - Spacers (fits over stud)
g - Cable barrel stud
h - Cable end guide stud

Pressure Test

1. Remove pressure service port plug from Port A.
2. Connect a pressure gauge to Port A.
3. Remove temperature sender and install thermocouple at Port B.



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a - Port A
b - Port B

4. Ensure that fluid temperature and shifting pressure meet specification.

Engine rpm	Shifting Pressure	
	Position A	Position B
2000	21.5-23.5 bar (312-341 psi)	21.5-23.5 bar (312-341 psi)

5. Check for leaks.

Transmission Repair

Mercury Marine stocks a limited number of replacement parts for these transmissions. ZF Marine has a network of distributors throughout the world to service their product. These distributors, in turn, have a dealer network to service the transmissions. Also, service manuals for each transmission can be obtained from ZF Marine.

For the location of your closest distributor or service literature contact:

ZF Marine
3101 Southwest 42nd St.
Fort Lauderdale, FL 33312
(954) 581-4099

NOTES:

DRIVES

Section 8D - ZF Marine/Hurth 45C In-Line Transmission

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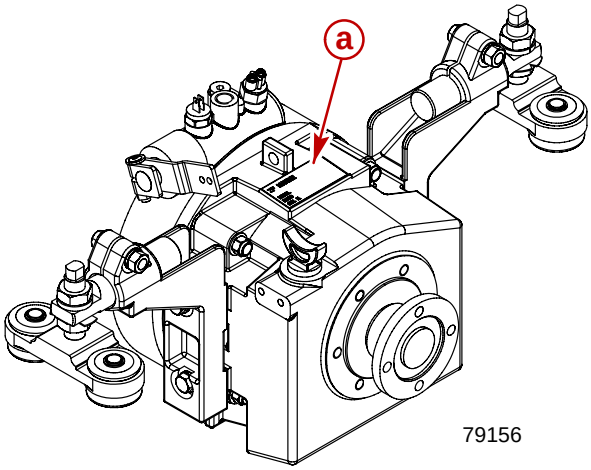
D

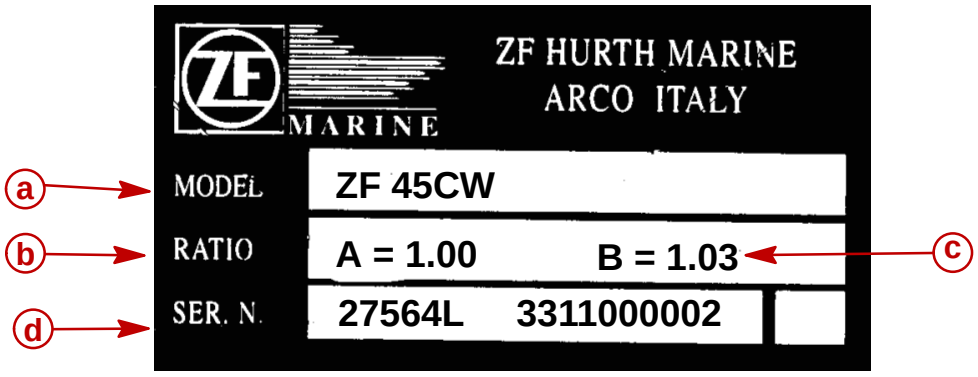
Identification

The transmission identification plate is located on the top rear of the transmission.



ZF Marine/Hurth 45C

a - Identification plate



Typical ZF Marine/Hurth Transmission identification plate

a - Transmission type
b - Gear ratio with shifting position “A”
c - Gear ratio with shifting position “B”
d - Serial number

Specifications

Operating Specifications

Description	Specification	
Shifting pressure	14-20 bar (203-290 psi)	
Operating temperature	54-79 degrees C (130-175 degrees F)	
Temperature switch settings +/– 10 degrees	Open	Close
	87.8 degrees C (190 degrees F)	110 degrees C (230 degrees F)

Ratios and Part Numbers

NOTE: *The ratio is shown on the identification plate. The ratio may be rounded off in some cases.*

Ratio (Normal)	ZF Marine/Hurth 45C	Mercury Part Number
1.0:1	ZF 45CW	864336P

Fluid Specifications

NOTICE
Unit Of Measurement: liters (U.S. quarts)
All capacities are approximate fluid measures.

NOTE: *Always use the dipstick to determine the exact fluid level.*

Model	Capacity	Fluid Type
45C Remote V-drive 0 degree	2.02 (2.14)	Dexron III Automatic Transmission Fluid
45C / Walter 5 degree	1.94 (2.05)	Dexron III Automatic Transmission Fluid
45C Tow Sports 15 degree	1.84 (1.95)	Dexron III Automatic Transmission Fluid

Pressure Specifications

Engine RPM	Shifting Pressure	
	Position A	Position B
2000	14-20 bar (203-290 psi)	14-20 bar (203-290 psi)

Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Engine Coupler Spine Grease	Transmission input shaft splines	92-802869A1
Liquid Neoprene	Connections on neutral safety switch	92-25711--3
Loctite 242 Threadlocker	Transmission bracket retention bolts	92-809821
Loctite 574 Surface Seal	Breather valve	Obtain locally
Loctite 703 Fast Cleaner	Filter element	Obtain locally
Dexron III Automatic Transmission Fluid	Breather valve	Obtain locally

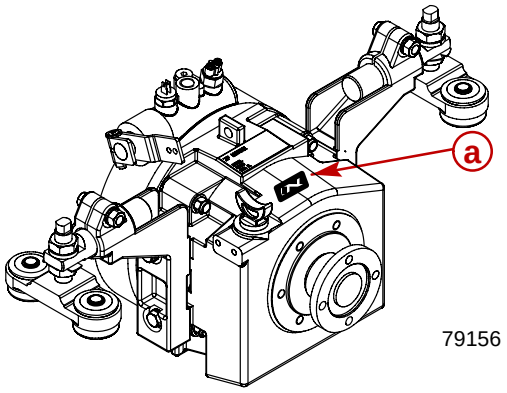
Tools

Description	Part Number
Thermometer [(3/8 in.-NPT, thread 18 - 132 degrees C (0 - 270 degrees F)	Obtain locally
Pressure gauge (0-500 psi), (3/8 in.-NPT)	

Precautions

Transmission gear ratio is marked on transmission identification plate, which is located on the top of transmission. Transmission rotation is described when viewed from the rear of transmission.

- Do not start or crank engine without fluid in transmission.
- Except in an emergency, never shift transmission at engine speeds above 1000 rpm.
- Free wheeling of one propeller (in a twin engine boat) at trolling speeds will not cause damage to the transmission; however, boat operation above trolling speed should be avoided. Ensure that proper fluid level exists before free wheeling propeller.
- Always replace oil cooler and hoses after a transmission failure or prior to installing a new or rebuilt transmission. Metallic particles from a failure tend to collect in the cooler and hoses and will gradually flow back into the fluid system and damage transmission.
- Always use specified oil cooler, hoses and fittings.



ZF Marine 45C Transmission

a - Output flange rotation decal

Torque Specifications

NOTE: *Securely tighten all fasteners not listed below.*

Description	Nm	lb-in.	lb-ft
Transmission to flywheel housing fasteners	61		45
Rear mount brackets fasteners	61		45
Coupler to output flange fasteners	68		50
Hose fittings at fluid cooler	34		25
Filter plate bolt	18		13

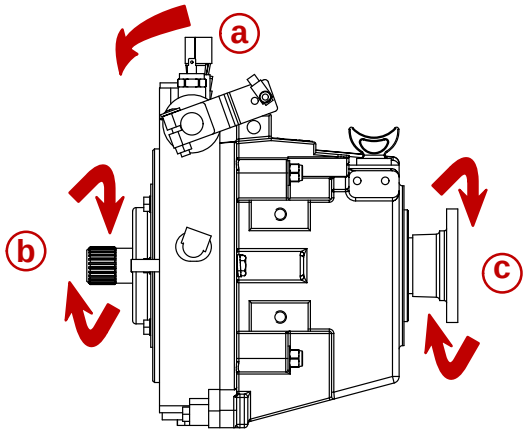
Transmission / Propeller Rotation

On MIE engines equipped with in-line transmissions having 1:1 gear ratio, the transmission output shaft rotation is the same as the engine rotation with the transmission in forward gear. Engine rotation is LH (CCW), so a LH propeller is required.

NOTE: *45C transmissions are not full power reversing.*

⚠ CAUTION

Avoid transmission failure. Shift cable connections at both the remote control and the transmission must always be in FORWARD position for forward movement and in the REVERSE position for reverse movement.



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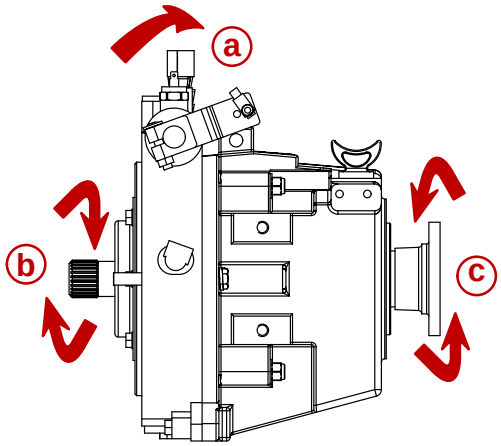
Forward

- **a** - Direction of shift lever engagement (toward flywheel)
- **b** - Engine/transmission input shaft shaft rotation direction (LH)
- **c** - Transmission output/propeller shaft rotation direction (LH)



77966

Reverse

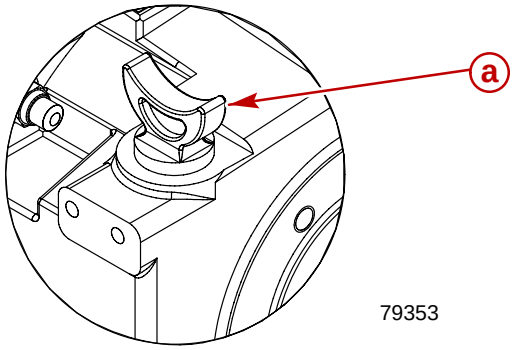
- **a** - Direction of shift lever engagement (away from flywheel)
- **b** - Engine/transmission input shaft rotation direction (LH)
- **c** - Transmission output/propeller shaft rotation direction (RH)

Fluid Level

Checking

IMPORTANT: Always check fluid level before operating transmission.

1. Loosen dipstick by turning the T-handle COUNTERCLOCKWISE.



a - Dipstick handle

2. Remove the dipstick and wipe it clean.

IMPORTANT: The dipstick requires an O-ring. Ensure that the O-ring remains in place.

3. Insert the dipstick in the transmission; do not screw it in.
4. Remove the dipstick and check fluid level.
5. If fluid is below top (full) line, add specified fluid through dipstick tube. Do not overfill. Reinstall dipstick with cap fully seated.

Changing

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

Transmission fluid should be changed when servicing the transmission.

1. Remove the breather valve, oil dipstick, and O-ring.
2. Clean the breather valve, allow to dry and coat with oil.

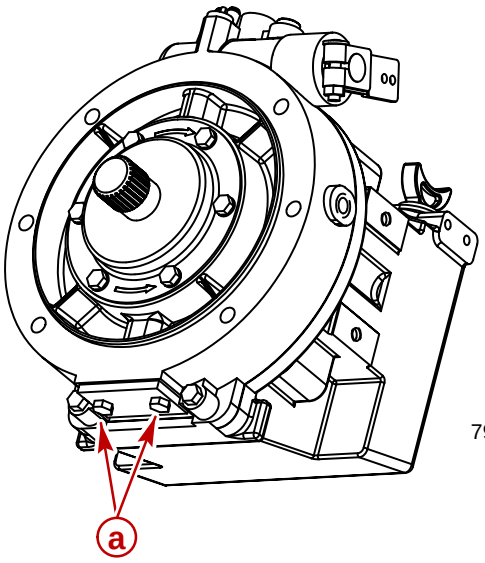
Description	Where Used	Part Number
Loctite 703 Fast Cleaner	Filter element	Obtain locally
Dexron III Automatic Transmission Fluid	Breather valve	Obtain locally

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

IMPORTANT: Removal and installation of this transmission is not covered in this manual. The information was not available at time of printing.

The transmission fluid change and filter service point is located on the bottom side of the transmission toward the engine flywheel. The transmission will have to be raised until the filter service point is accessible.



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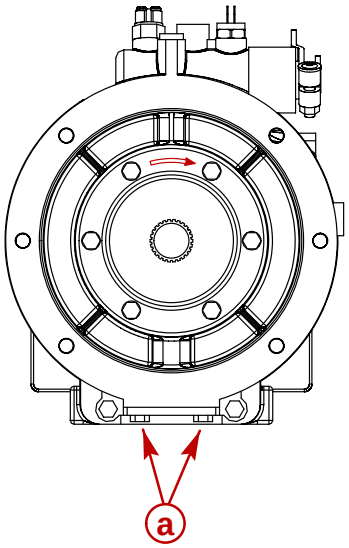


79151

a - Filter plate bolt, and washer (2)

3. Place a suitable container under the filter plate to catch the oil.
4. Remove 2 bolts, 2 washers, filter plate, seal and filter element.

5. Allow the oil to completely drain from transmission.
6. Check the oil for the following foreign matter:

- **Metal particles:** A few small particles are normal. Larger metal chips are an early sign of transmission failure which may mean the transmission should be disassembled and inspected for internal damage.
- **Rubber particles:** Indication of cooler hose wear. The hoses should be inspected for cracks or fraying. Replace the damaged hoses.

7. Inspect the seal for wear and replace if necessary.
8. Clean the filter element with suitable cleaner.

Description	Where Used	Part Number
Loctite 703 Fast Cleaner	Filter element	Obtain locally

9. Install the filter element, seal, and filter plate.
10. Install the bolts and washers. Torque the bolts.

Description	Nm	lb-in.	lb-ft
Filter plate bolt	18		13

11. Apply sealant to threads of breather valve and install to transmission. Secure hand-tight.

Description	Where Used	Part Number
Loctite 574 Surface Seal	Breather valve	Obtain locally

12. Fill the transmission with specified fluid at dipstick hole.

NOTICE
Unit Of Measurement: liters (U.S. quarts)
All capacities are approximate fluid measures.

NOTE: *Always use the dipstick to determine the exact fluid level.*

Model	Capacity	Fluid Type
45C Remote V-drive 0 degree	2.02 (2.14)	Dexron III Automatic Transmission Fluid
45C / Walters 5 degree	1.94 (2.05)	Dexron III Automatic Transmission Fluid
45C Tow Sports 15 degree	1.84 (1.95)	Dexron III Automatic Transmission Fluid

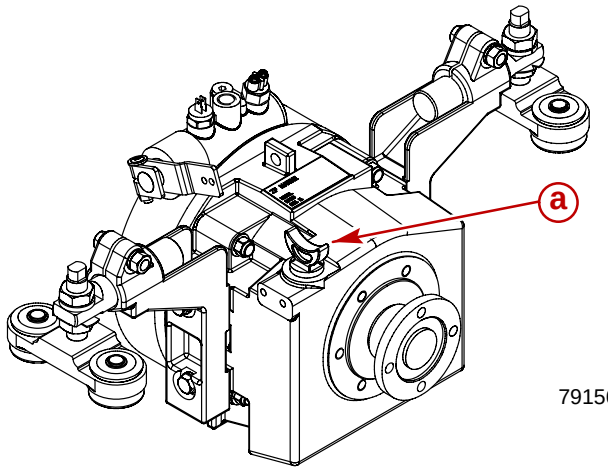
13. Install the dipstick and O-ring.

Filling

IMPORTANT: Use only specified transmission fluid.

IMPORTANT: The fluid level is checked with the dipstick not inserted into the housing (not screwed in).

1. Remove dipstick.
2. Fill the transmission with fluid through the dipstick hole to bring the level up to the full mark.
3. Replace the dipstick.



a - Dipstick

IMPORTANT: Do not start or crank the engine without fluid in the transmission.

IMPORTANT: To accurately check the fluid level, operate the engine at 1500 rpm for 2 minutes immediately prior to checking the fluid level.

4. Start the engine and operate at 1500 rpm for 2 minutes to fill all hydraulic circuits.
5. Stop the engine and quickly check the fluid level. Add transmission fluid, if necessary, to bring the level up to the full mark on the dipstick.

Removal

Removal and installation of this transmission is not covered in this manual. The information was not available at time of printing.

POWER STEERING

Section 9A - Power Steering Pump

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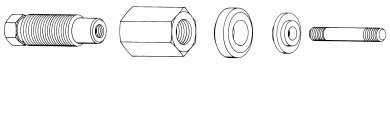
9A

Lubricants / Sealants / Adhesives

Description	Where Used	Part Number
Power Trim And Steering Fluid	Power steering pump shaft and power steering pump	92-802880A1
Dexron lll Automatic Transmission Fluid		Obtain locally

Special Tools

Pulley Pusher Installer		
 73670	Installs the pulley on the power steering pump	91-93656A1

Kent-Moore Tools

Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 774-9500	
Description	**Part Number**
Power Steering Pump Pulley Remover	J-25034

Precautions

⚠ WARNING

Avoid personal injury or death and power package damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package.

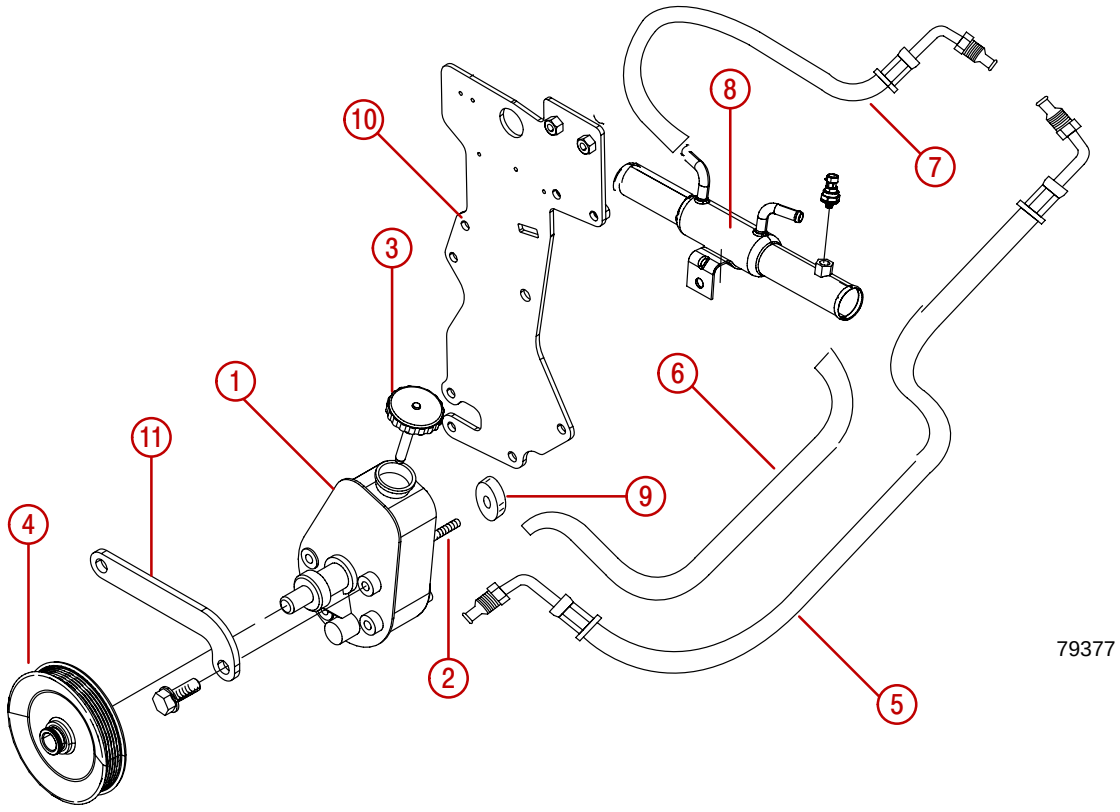
⚠ CAUTION

Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation.

⚠ CAUTION

Do not pry on the power steering pump or the alternator when adjusting belt tension. Serious damage may result.

Power Steering Pump Assembly Exploded View



1 - Power steering pump and reservoir
2 - Power steering mounting stud
3 - Cap/dipstick
4 - Pulley
5 - High pressure hose (fittings on both ends)
6 - Low pressure hose (pump to fluid cooler)
7 - Low pressure hose (control valve to-fluid-cooler)
8 - Power steering fluid cooler
9 - Lower mounting stud spacer (if equipped)
10 - Bracket
11 - Brace

Torque Specifications

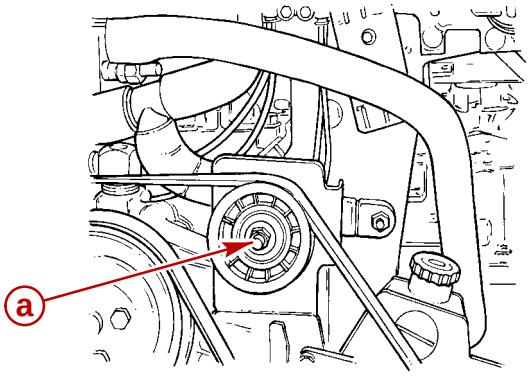
Description	Nm	lb-in.	lb-ft
Power steering pump mounting fasteners	41		30
Power steering hose fittings	31		23
Power steering pump housing studs	47		35

Power Steering Pump Pulley Replacement

Removal

NOTE: *The power steering pump pulley may be removed and installed while the power steering pump assembly remains mounted to the engine.*

1. Loosen the adjusting nut and remove the serpentine belt from the power steering pulley.



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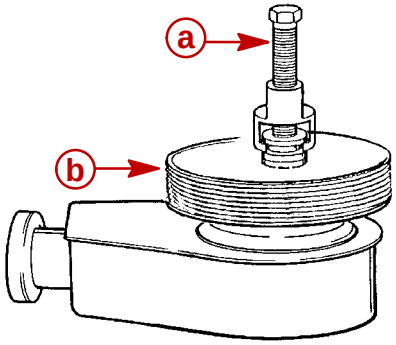
a - Adjusting nut

2. Install the Pulley Removal Tool on the end of the power steering pulley and the shaft.

Description	Part Number
Power Steering Pump Pulley Remover	J-25034

3. While holding the Pulley Removal Tool with a suitable wrench, turn the threaded bolt until the power steering pulley is removed.



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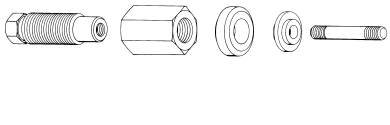
Power steering pump assembly removed from engine to show clarity

a - Typical Pulley Removal Tool
b - Power steering pump pulley

Installation

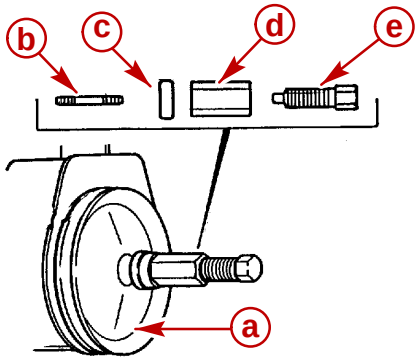
1. Install the power steering pump pulley using the Pulley Pusher Installer.
   a. Thread the stud from the Pulley Pusher Installer Tool completely into the power steering pump shaft.

Pulley Pusher Installer		
 73670	Installs the pulley on the power steering pump.	91-93656A1

   b. Lubricate the power steering pump shaft.

Description	Where Used	Part Number
Power Trim and Steering Fluid	Power steering pump shaft	92-802880A1

   c. Place the power steering pulley on the power steering pump shaft.
   d. Place the bearing from the pulley pusher installer tool over the Pulley Pusher Installer Tool stud. Do not use the spacer from the kit.
   e. Thread the Pulley Pusher Installer Tool nut onto the pulley pusher installer tool shaft.
   f. Thread the Pulley Pusher Installer Tool shaft and nut onto the Pulley Pusher Installer Tool stud (threaded into the power steering pump shaft).
   g. Turn the Pulley Pusher Installer Tool nut until the face of the power steering pulley is even with the edge of the power steering shaft.



75751

a - Power steering pump pulley
b - Pulley Pusher Installer Tool stud
c - Pulley Pusher Installer Tool bearing
d - Pulley Pusher Installer Tool nut
e - Pulley Pusher Installer Tool shaft

Power Steering Pump Assembly

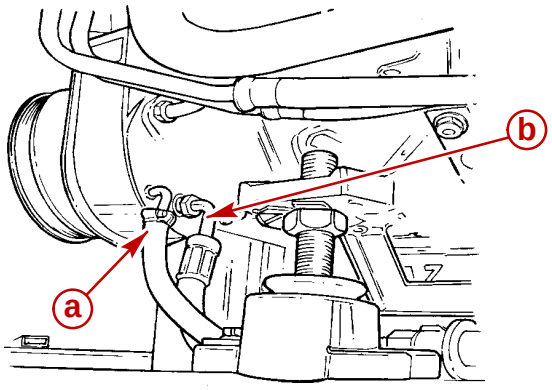
Removal

1. Remove the serpentine belt from the power steering pulley.

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

2. Drain the fluid from the power steering pump assembly.
   a. Allow fluid to cool. Remove the power steering pump cap/dipstick.
   b. Remove the power steering high pressure hose and the power steering low pressure hose from the power steering pump.
   c. Drain fluid into a suitable container.

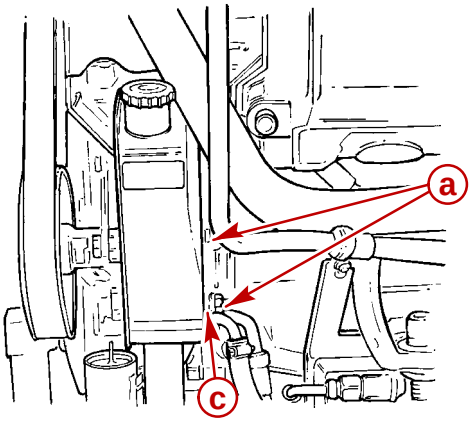


77827

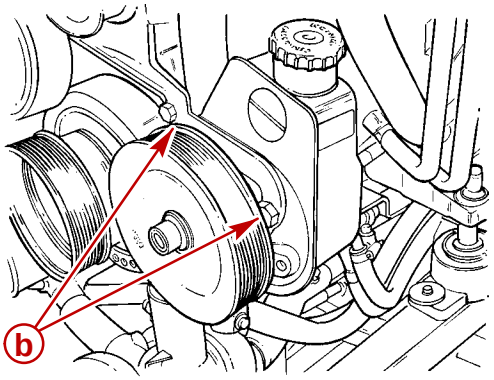
Typical location of power steering pump assembly

a - Power steering low pressure hose
b - Power steering high pressure hose

3. Remove the bolts and nuts from the power steering pump and mounting brackets.



77829



77830

Typical power steering pump assembly mounting hardware

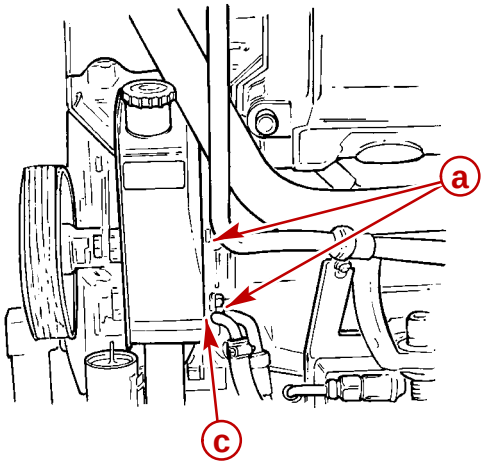
a - Nut
b - Bolts
c - Spacer (if equipped)

4. Remove the power steering pump from the mounting brackets.
5. If equipped, remove spacer from the lower power steering mounting stud.

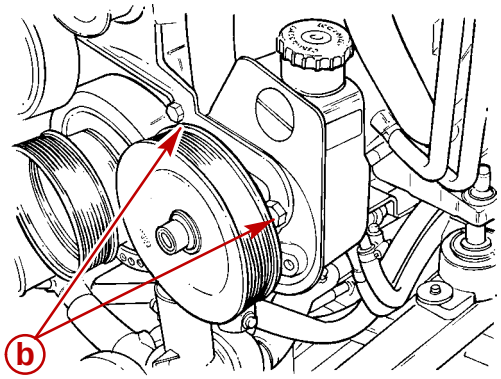
Installation

IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.

1. If equipped, place the spacer on the lower power steering mounting stud.
2. Place the power steering pump on the mounting brackets.
3. Install and torque the bolts and nuts.



77829



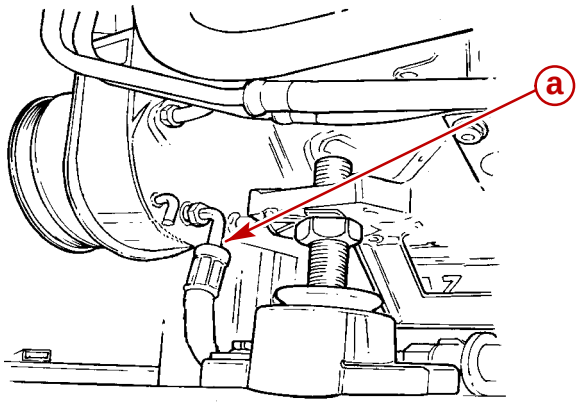
77830

Typical power steering pump assembly mounting hardware

a - Nuts
b - Bolts
c - Spacer (if equipped)

Description	Nm	lb-in.	lb-ft
Power steering pump bolt and nut to mounting brackets	41		30

4. Using a new O-ring, install the power steering high pressure hose fitting to the power steering pump assembly. Tighten and torque the hose fitting.

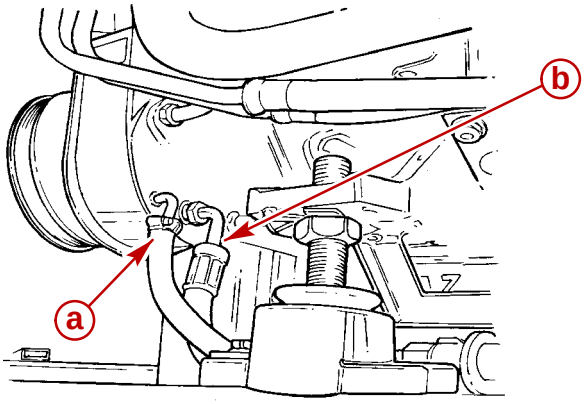


77827

a - Power steering high pressure hose and fitting

Description	Nm	lb-in.	lb-ft
All power steering hose fittings	31		23

5. Connect the power steering low pressure hose to power steering pump assembly and. secure with hose clamp.



77827

a - Power steering low pressure hose and hose clamp
b - Power steering high pressure hose and fitting

Replacing Belt And/Or Adjusting Tension

Refer to **Section 1B** for more information.

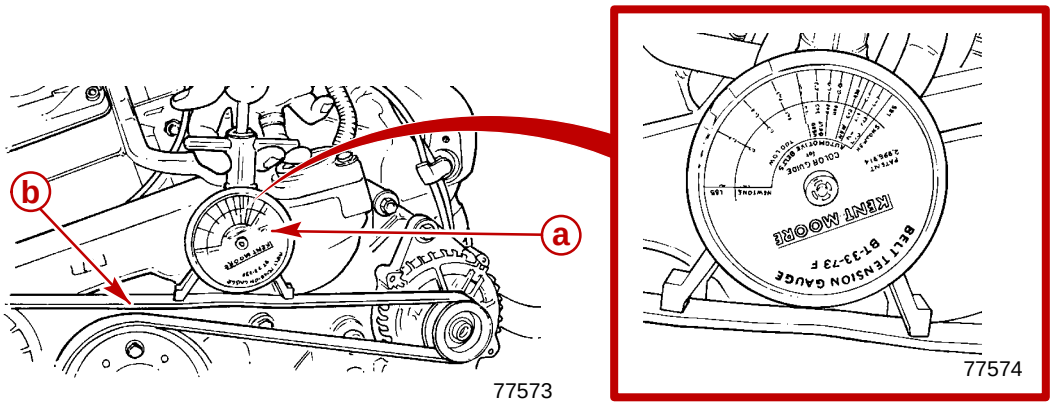
Removal

1. Loosen the 5/8 in. locking nut on the adjustment stud.
2. Turn the adjustment stud and loosen the belt.
3. Remove the serpentine drive belt.

Installation and Adjustment

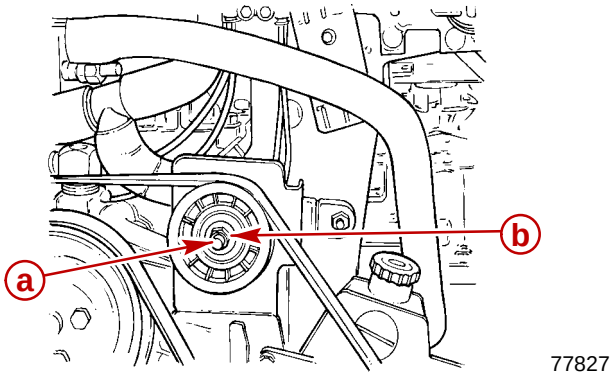
1. Install the serpentine drive belt onto the pulleys.
2. Put a wrench on the adjustment stud 5/8 in. locking nut.
3. Use a 5/16 in. socket and tighten the adjusting stud to adjust the belt deflection.
4. Ensure that the correct deflection has been obtained.
   a. Push down with moderate thumb pressure on the longest stretch of belt.

b. Attach the Kent Moore Belt Tension Gauge to the belt. The gauge has different ranges for new and used belts.



a - Kent Moore tension gauge
b - Serpentine belt

5. While holding the adjustment stud at the correct belt tension, tighten the 5/8 in. locking nut.



a - 5/8 in. locking nut
b - 5/16 in. adjusting stud

6. Operate the engine for a short period of time and recheck the belt adjustment.

Filling And Bleeding

IMPORTANT: The power steering system must be filled exactly as explained to ensure that all air is bled from the system. All air must be removed or fluid in the pump may foam during operation and be discharged from the pump reservoir. Foamy fluid may also cause the power steering system to become spongy, which may result in poor boat control.

1. With the engine stopped, center the sterndrive unit.
2. Remove the fill cap / dipstick from the power steering pump.

IMPORTANT: Use only specified fluid in the power steering system.

3. Add specified fluid, as required, to bring the level up to the FULL COLD mark on the dipstick.
4. Turn the steering wheel back and forth to the end of travel in each direction several times.
5. Recheck the fluid level and add fluid, if necessary.
6. Install the vented fill cap. Tighten securely.

⚠ CAUTION

Do not operate engine without water being supplied to seawater pickup pump or pump impeller may be damaged and subsequent overheating damage to engine may result.

7. Start the engine and operate at fast idle (1300 rpm) until the engine reaches normal operating temperature. During this time, turn the steering wheel back and forth to the end of travel in each direction several times.
8. Center the sterndrive unit and stop the engine.
9. Remove the fill cap from the pump.
10. Allow any foam in the pump reservoir to disperse.
11. Check the fluid level and add fluid, as required, to bring the level up to the FULL HOT mark on the dipstick. Do not overfill**.**
12. Reinstall the fill cap. Tighten securely.

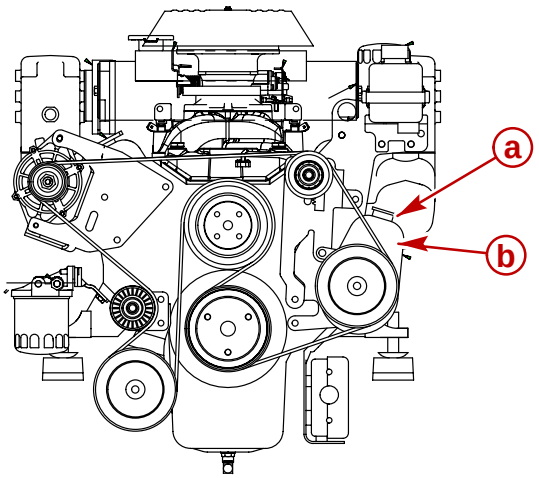
IMPORTANT: The sterndrive unit must be centered and the power steering fluid must be hot to accurately check the fluid level.

13. If the fluid is still foamy (in Step 10.), repeat Steps 7. through 12. until the fluid does not foam and the level remains constant.

Checking Fluid Level

ENGINE WARM

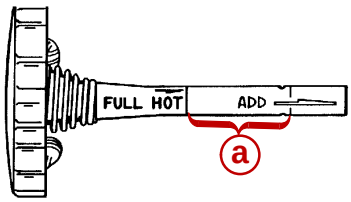
1. Stop the engine. Center the sterndrive unit.
2. Remove the fill cap / dipstick from the power steering pump and note the fluid level.



77108

a - Fill cap / dipstick
b - Power steering pump

3. The level should be between the “FULL HOT” mark and the “ADD” mark on the dipstick.



72518

a - Proper fluid level with engine warm

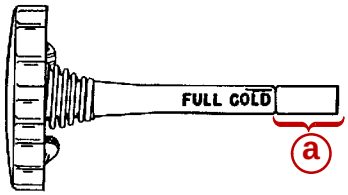
4. If the level is below the “ADD” mark, but fluid is still visible in the pump reservoir, add the required amount of fluid through the fill cap opening to bring the level up to the “FULL HOT” mark on the dipstick. Do not overfill.

Description	Where Used	Part Number
Power Trim and Steering Fluid or Dexron III Automatic Transmission Fluid	Power steering system	92-802880A1

5. If fluid is not visible in the reservoir, a leak exists in the power steering system. Find the cause and correct.

ENGINE COLD

1. With the engine stopped, center the sterndrive unit.
2. Remove the fill cap / dipstick from the power steering pump and note the fluid level.
3. The level should be between the FULL COLD mark and the bottom of the dipstick.



72519

a - Proper fluid level with engine cold

4. If the level is below the bottom of the dipstick, but fluid is still visible in the pump reservoir, add the required amount of specified fluid through the fill cap opening to bring the level up to the “FULL COLD” mark on the dipstick. Do not overfill.
5. If fluid is not visible in the reservoir, a leak exists in the power steering system. Find the cause and correct.

Hydraulic Hoses And Fluid Cooler

The following information is provided to assist in the replacement of the power steering fluid hoses and to assure proper routing and connection to the cooler.

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leaking.

IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.

High Pressure Hose (Pump To Control Valve)

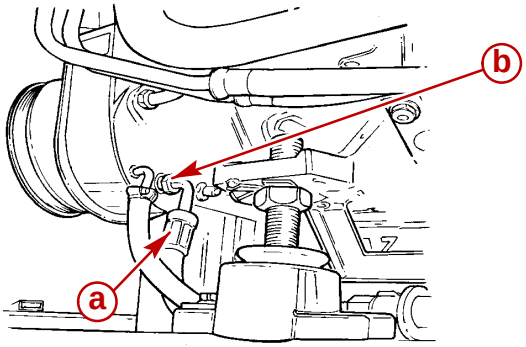
REMOVAL

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

NOTE: *Catch the fluid that drains from the pump and the hoses in a suitable container.*

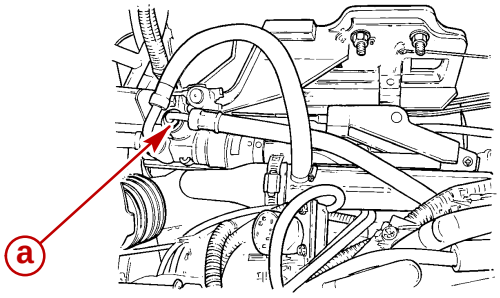
1. Note the position and the routing of the power steering high pressure hose before removal.
2. Remove the power steering high pressure hose and the O-ring from the power steering pump assembly.



77827

a - Power steering high pressure hose
b - Power steering hose fitting (O-ring not shown)

3. Remove the power steering high pressure hose fitting and the O-ring from the control valve at the transom. Remove the hose.



77845

a - Power steering high pressure hose and fitting (O-ring not shown)

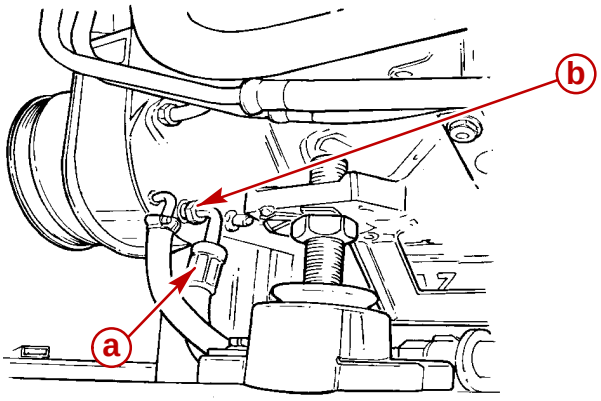
INSTALLATION

⚠ CAUTION

Route the hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.

1. Route the power steering high pressure hose in the same position as prior to removal.
2. Install a new O-ring and the power steering high pressure hose and fitting to the power steering pump assembly. Torque fitting.

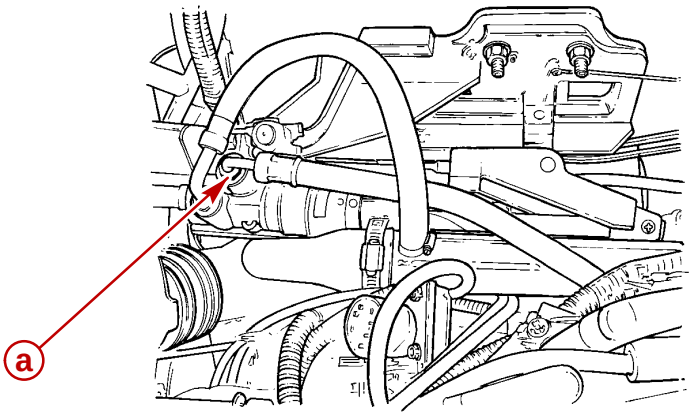


77827

a - Power steering high pressure hose
b - Power steering hose fitting (O-ring not shown)

Description	Nm	lb-in.	lb-ft
Power steering hose fitting	31		23

3. Install the power steering high pressure hose fitting and the O-ring to the control valve. Torque fitting.



77845

a - Power steering high pressure hose fitting (O-ring not shown)

Description	Nm	lb-in.	lb-ft
Power steering hose fitting	31		23

4. Fill and air bleed the system. Refer to **Section 1B**.

Low Pressure Hose (Pump To Fluid Cooler)

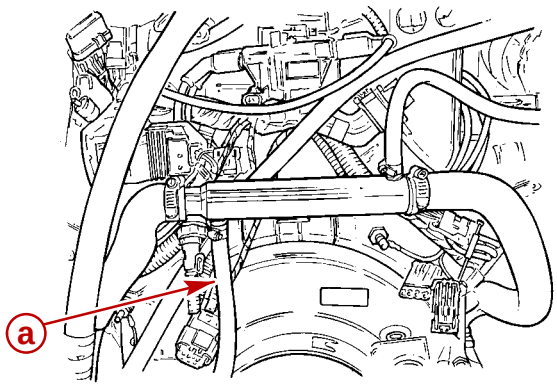
REMOVAL

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

NOTE: *Catch the fluid that drains from the hose, the cooler, and the pump in a suitable container.*

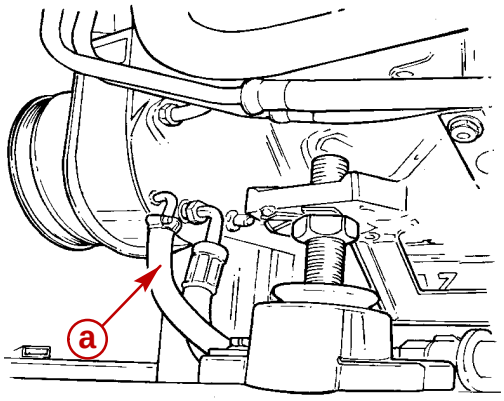
1. Note the position and the routing of the power steering low pressure hose before removal.
2. Loosen the hose clamp and remove the power steering low pressure hose from the power steering fluid cooler.



77826

a - Power steering low pressure hose and hose clamp

3. Loosen the hose clamp and remove the power steering low pressure hose from the power steering pump assembly.

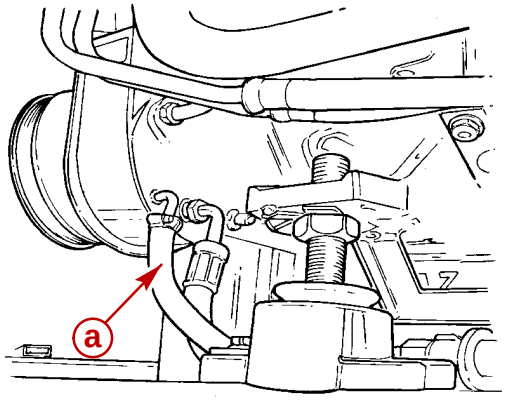


77827

a - Power steering low pressure hose and hose clamp

INSTALLATION

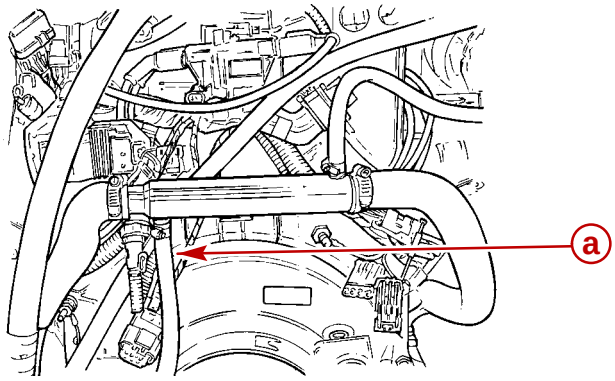
1. Route the power steering low pressure hose in the same position as prior to removal.
2. Install the new power steering low pressure hose to the power steering pump assembly and secure with hose clamps.



77827

a - Power steering low pressure hose and hose clamp

3. Install the new power steering low pressure hose to the power steering fluid cooler and secure with hose clamps.



77826

a - Power steering low pressure hose and hose clamp

4. Fill and air bleed the system. Refer to **Section 1B**.

Low Pressure Hose (Control Valve To Fluid Cooler)

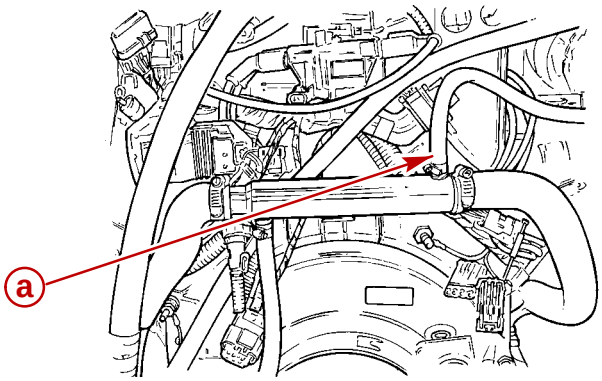
REMOVAL

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

NOTE: *Catch the fluid that drains from the hose, the cooler, and the pump in a suitable container.*

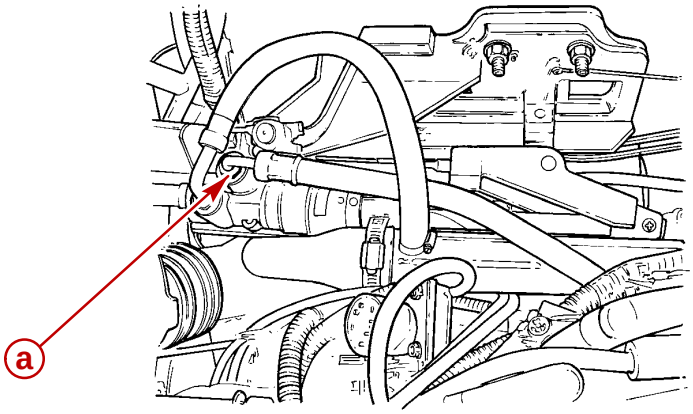
1. Note the position and the routing of the power steering low pressure hose before removal.
2. Loosen the hose clamp and remove the power steering low pressure hose from the power steering fluid cooler.



77826

a - Power steering low pressure hose and hose clamp

3. Remove the power steering low pressure hose fitting and the O-ring from the control valve at the transom. Remove the hose.



77845

a - Power steering low pressure hose hose fitting (O-ring not shown)

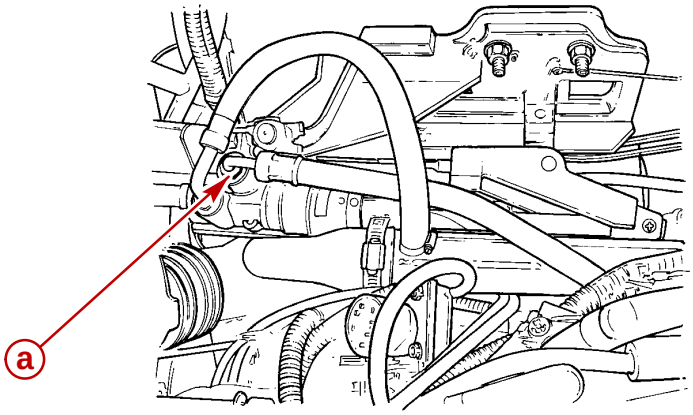
INSTALLATION

⚠ CAUTION

Route the hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or overtighten the hose fittings.

1. Route the power steering low pressure hose in the same position as prior to removal.
2. Install and torque the new power steering low pressure hose fitting and the O-ring to the control valve.

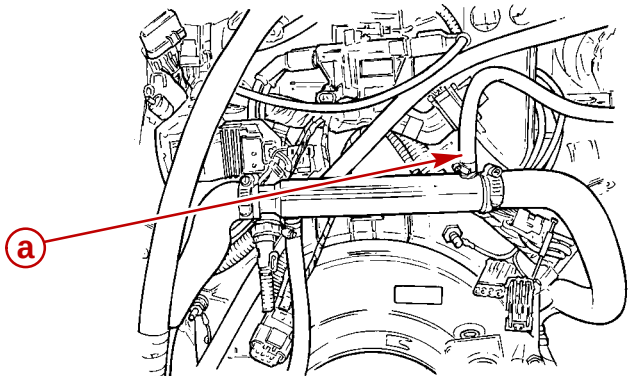


77845

a - Power steering low pressure hose fitting (O-ring not shown)

Description	Nm	lb-in.	lb-ft
Power steering hose fitting	31		23

3. Install the new power steering low pressure hose to the power steering fluid cooler and secure with hose clamps.



77826

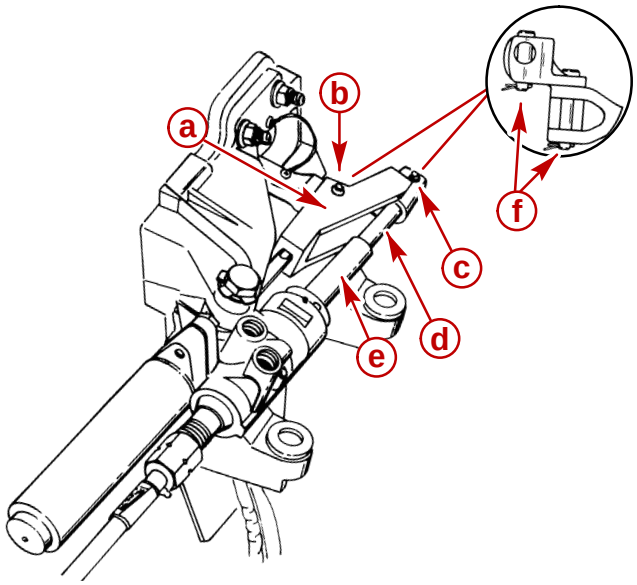
a - Power steering low pressure hose and hose clamp

4. Fill and air bleed the system. Refer to **Section 1B**.

Power Steering System Pressure Test

The following instructions are arranged so that a defective part can be detected by the process of elimination. It is suggested that the order of the instructions be followed so that the Power Steering System can be tested effectively.

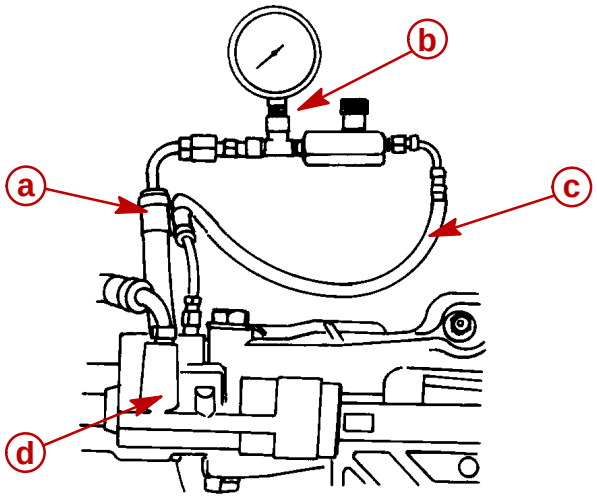
1. Remove front and rear clevis pins.
2. Retract cable into cable guide tube.



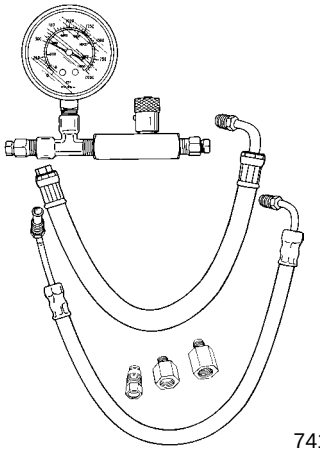
71901

a - Clevis
b - Rear clevis pin
c - Forward clevis pin
d - Steering cable end
e - Cable guide tube
f - Cotter pins

3. Assemble and install test gauge.



a - Pump pressure hose
b - Test gauge assembly
c - Gauge to control valve hose
d - Control valve

Power Steering Test Gauge Kit		
 74167	Tests the power steering system pressure.	91-38053A4

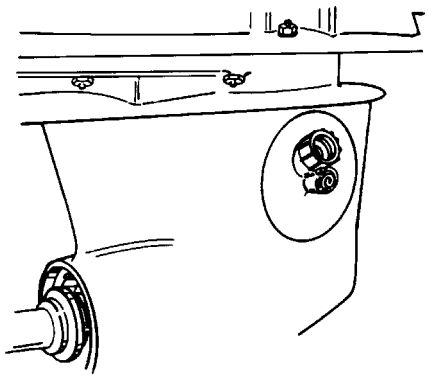
4. Open valve on gauge completely.

⚠ CAUTION

Do not operate engine without cooling water being supplied to water pickup holes in gear housing, or overheating damage to engine may result.

NOTE: *For complete instructions for attaching a flush test device to the various water inlets, refer to* ***Sterndrive Water Pickups in Section 1B.***

5. Connect a flush test device to sterndrive unit. Partially open water tap (approximately 1/2 maximum) and allow cooling system to fill completely. Cooling system is full when water is discharged through the propeller. Do not use full water tap pressure.



22029

Standard Bravo shown

6. Start engine and operate at 1000-1500 rpm until engine reaches normal operating temperature.
7. With engine at idle speed, test gauge reading should be between 483 and 862 kPa (70 and 125 psi). If not, proceed as follows:

If lower than 483 kPa (70 psi), proceed to **Pump Pressure Test**.

If higher than 862 kPa (125 psi), check for hose restrictions in the system.

⚠ CAUTION

Do not lug pump at maximum pressure for more than 5 seconds in next step or damage to power steering pump may occur.

8. Push in, then pull steering cable **momentarily**. Gauge reading should show an instant increase in pressure when block is pushed in both directions.
9. Push steering cable in until booster cylinder piston rod is fully retracted. With piston rod in this position, **momentarily** push steering cable in until maximum pressure reading is obtained.

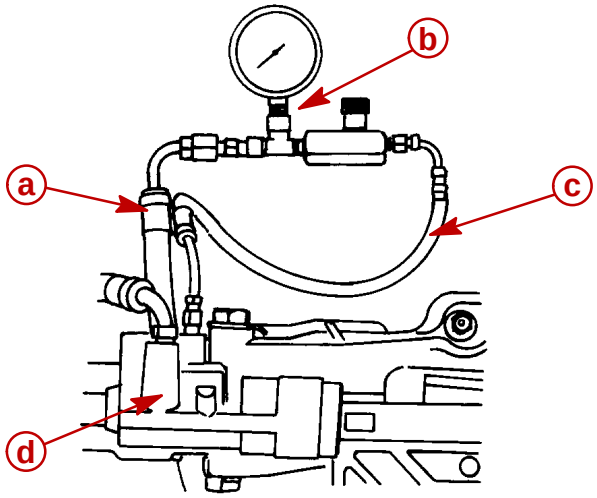
- **If pressure is above 6897 kPa (1000 psi),** system pressure is good.
- **If pressure is below 6897 kPa (1000 psi),** conduct **Pump Pressure Test**.

Pump Pressure Test

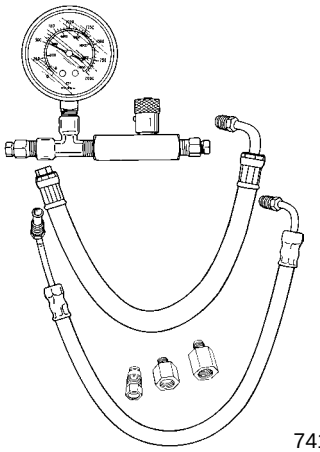
⚠ CAUTION

In performing the following test, do not lug pump at maximum pressure for more than 5 seconds or damage to power steering pump may occur.

1. Install test gauge.



a - Pump pressure hose
b - Test gauge assembly
c - Gauge to control valve hose
d - Control valve

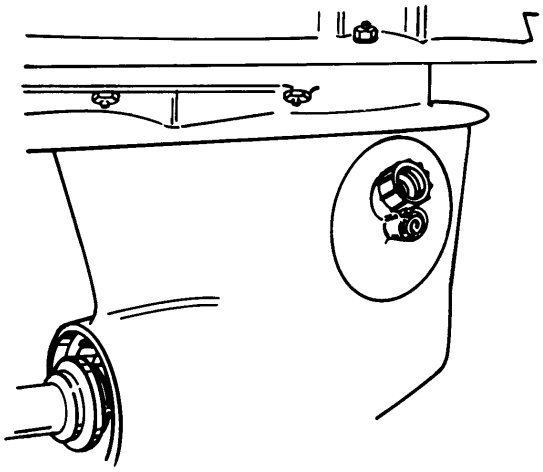
Power Steering Test Gauge Kit		
 74167	Tests the power steering system pressure.	91-38053A4

⚠ CAUTION

Do not operate engine without cooling water being supplied to water pickup holes in gear housing, or overheating damage to engine may result.

NOTE: *For complete instructions for attaching a flush test device to the various water inlets, refer to* ***Sterndrive Water Pickups in Section 1B.***

2. Connect a flush test device to sterndrive unit. Partially open water tap (approximately 1/2 maximum) and allow water to enter cooling system. Do not use full water tap pressure.



22029

Standard Bravo shown

3. Start engine and operate at 1000-1500 rpm until engine reaches normal operating temperature.
4. Close test gauge valve just long enough to obtain maximum pressure reading.
5. Close and open valve 3 times. Record highest pressure reading attained each time.
   a. **If pressure readings are between 7932-8621 kPa (1150 and 1250 psi) and are within a range of 345 kPa (50 psi),** the pump is within specifications. If the **pump** tests OK, but system pressure was low (as tested under **Power Steering System Pressure Test**), refer to the appropriate Mercury MerCruiser service manual.
   b. **If pressure readings are between 7932-8621 kPa (1150-1250 psi), but are not within a 345 kPa (50 psi) range,** the power steering pump flow control valve is sticking or pump hydraulic system is dirty.
   c. **If pressure readings are constant, but below 6897 kPa (1000 psi),** replace power steering pump.

WATER FLOW DIAGRAMS

Section 10A - General Information

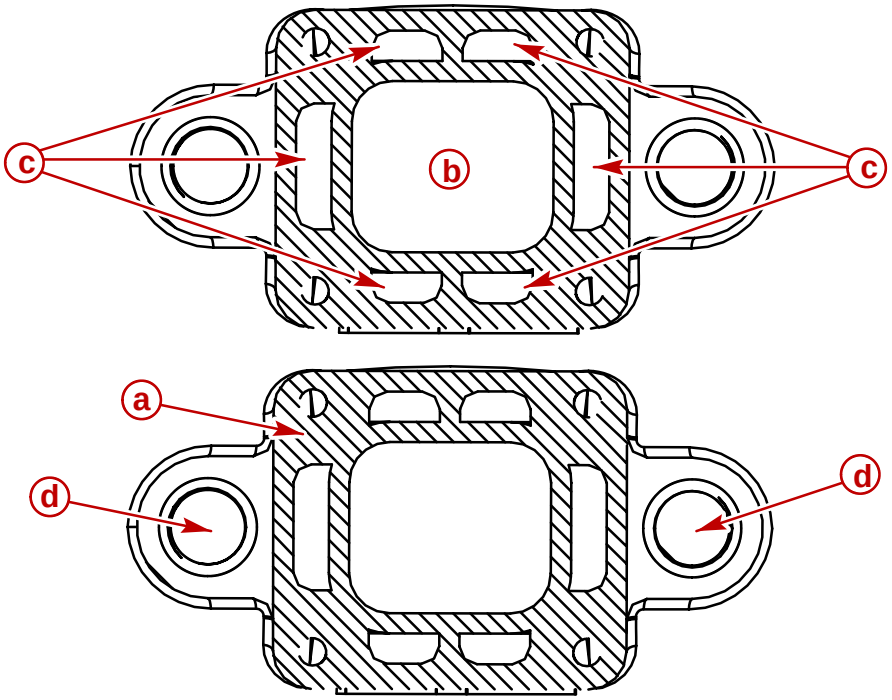
Table of Contents

Wet Joint Models	**10A-2**
Dry Joint Models	**10A-3**
Cold Risers	10A-4
Warm Risers	10A-4

10 A

Wet Joint Models

Wet joint is a description based on the style of exhaust system on these engines. The wet joint exhaust system confines both the engine seawater and exhaust gases with the same gasket sealing surface at the exhaust manifold to elbow joint (wet joint). In the exhaust elbow, the engine seawater and exhaust gases are mixed and discharged together. This system was used on engines produced prior to 2002. These engines are equipped with cold manifolds.

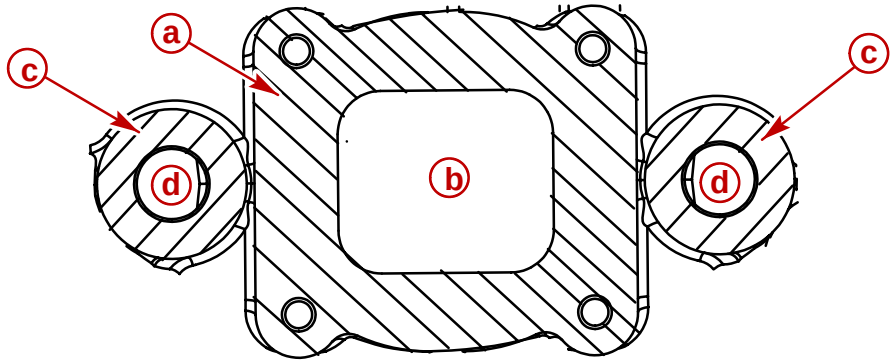


a - Gasket sealing surface
b - Exhaust gas flow
c - Water flow
d - Hex plugs

Sterndrive engines equipped with the wet joint exhaust system are 0M599999 and below. Inboard engines equipped with the wet joint exhaust system are 0M316999 and below. Exhaust components should be examined rather than relying solely on the serial number range as some engines may have been modified. Refer to **Section 7** for more information on exhaust system identification.

Dry Joint Models

Dry joint is a description based on the style of exhaust system on these engines. In a dry joint exhaust system the engine seawater and the exhaust gas are separated by different gasket sealing surfaces at the exhaust manifold to elbow joint (dry joint). In the exhaust elbow, the engine seawater and exhaust gases are mixed and discharged together.



78748

a - Exhaust gas gasket sealing surface
b - Exhaust gas flow
c - Seawater gasket sealing surfaces
d - Seawater flow

All dry joint models have warm manifolds, although early models were equipped with cold risers and later models equipped with warm risers. Fluid from the exhaust manifold is prevented from entering a cold riser while fluid enters the warm riser from the exhaust manifold.

Sterndrive engines equipped with the dry joint exhaust system are 0M600000 and above. Inboard engines equipped with the dry joint exhaust system are 0M317000 and above. Warm risers began production on sterndrive models with 0M615000 and on inboard models with 0M390000.

Exhaust components should be examined rather than relying solely on the serial number range as some engines may have been modified. Refer to **Section 7** for more information on exhaust system identification.

Cold Risers

Cold riser models have the dry joint exhaust system and warm manifolds. Fluid from the exhaust manifold is prevented from entering a cold riser.

Sterndrive engines equipped with the dry joint exhaust system and cold risers will be 0M600000 through 0M614999. Inboard engines equipped with the dry joint exhaust system and cold risers will be 0M317000 through 0M389999.

Exhaust components should be examined rather than relying solely on the serial number range as some engines may have been modified. Refer to **Section 7** for more information on exhaust system identification.

Warm Risers

Warm riser models have the dry joint exhaust system and warm manifolds. Fluid from the exhaust manifold enters the warm riser.

Sterndrive engines equipped with the dry joint exhaust system and warm risers will be 0M615000 and above. Inboard engines equipped with the dry joint exhaust system and warm risers will be 0M390000 and above.

Exhaust components should be examined rather than relying solely on the serial number range as some engines may have been modified. Refer to **Section 7** for more information on exhaust system identification.

WATER FLOW DIAGRAMS

Section 10B - Seawater Cooled Carbureted Models

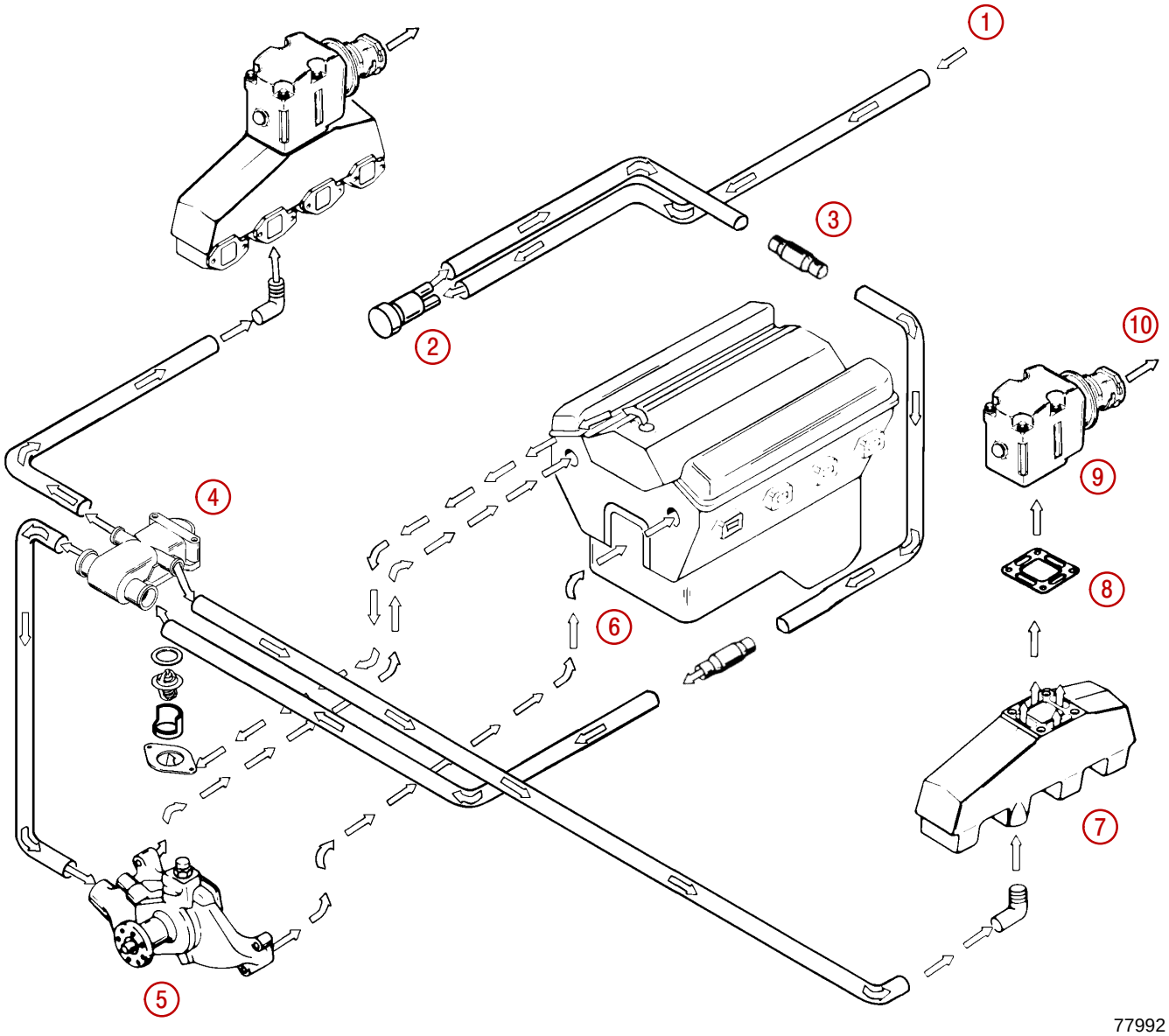
Table of Contents

Sterndrive 0M599999 And Below 10B-2
Inboard 0M316999 And Below 10B-3
Sterndrive 0M600000 Through 0M614999 ..... 10B-4
Inboard 0M317000 And Above 10B-5
Sterndrive With Risers 0M600000 And Above 10B-6
In-line Inboard With Risers 0M317000 And Above 10B-7

10 B

Sterndrive 0M599999 And Below

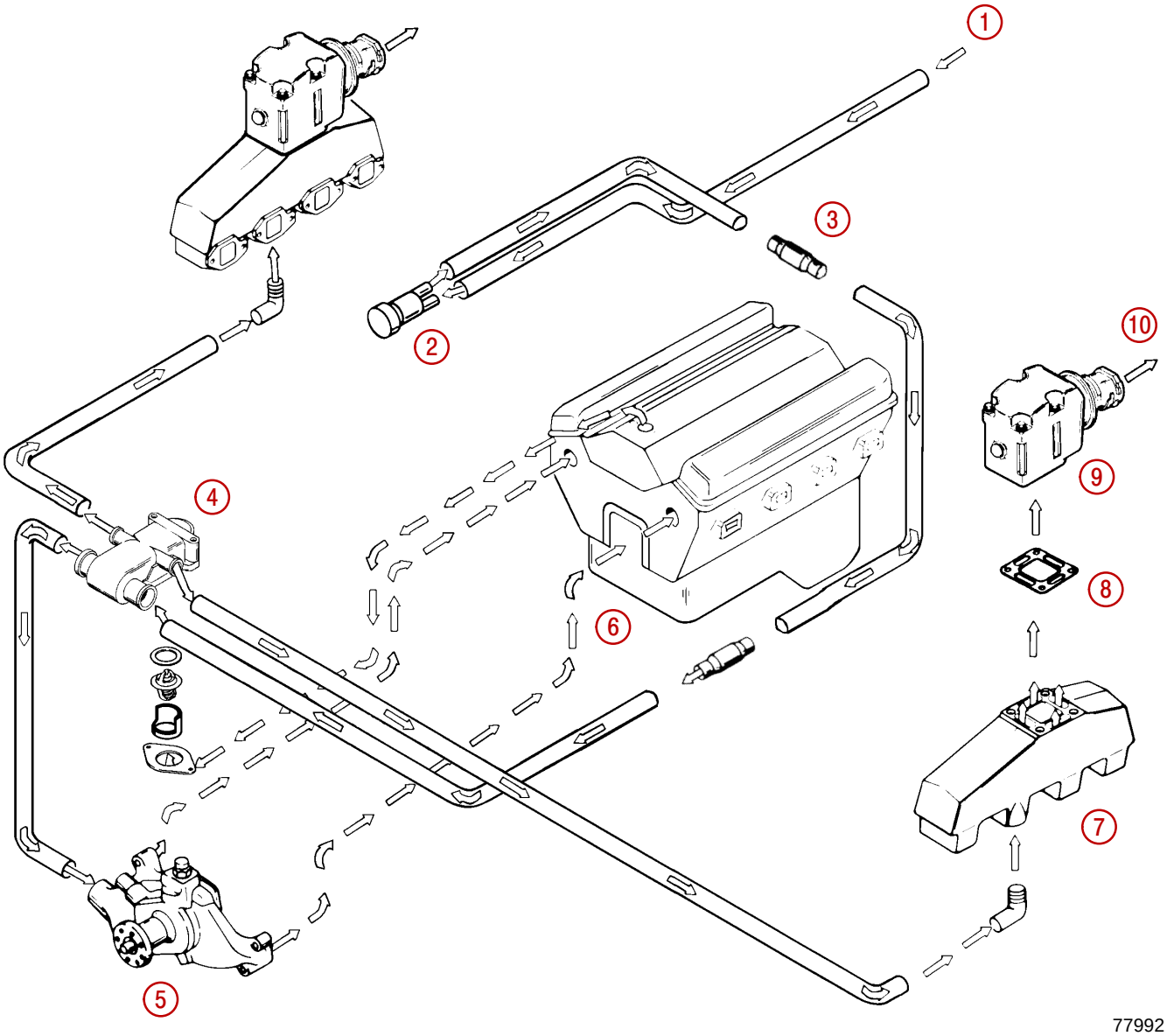
NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water flow paths remain similar on all engines.*



1 - Seawater intake
2 - Seawater pump (Bravo models)
3 - Power steering cooler (if equipped)
4 - Thermostat housing and cover assembly
5 - Engine water circulating pump
6 - Engine block and cylinder head assembly
7 - Exhaust manifold, typical
8 - Gasket
9 - Exhaust elbow assembly, typical
10 - Water flow overboard

Inboard 0M316999 And Below

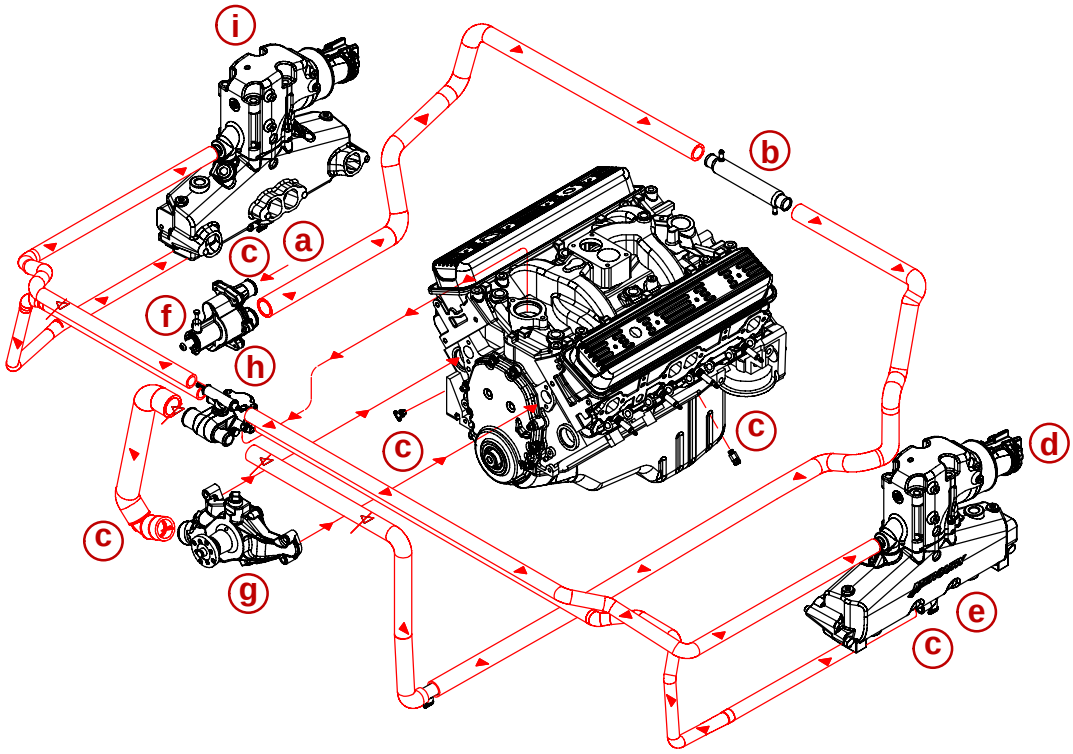
NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water flow paths remain similar on all engines.*



In-line model shown, v-drive similar

1 - Seawater intake
2 - Seawater pump
3 - Transmission cooler
4 - Thermostat housing and cover assembly
5 - Engine water circulating pump
6 - Engine block and cylinder head assembly
7 - Exhaust manifold, typical
8 - Gasket
9 - Exhaust elbow assembly, typical
10 - Water flow overboard

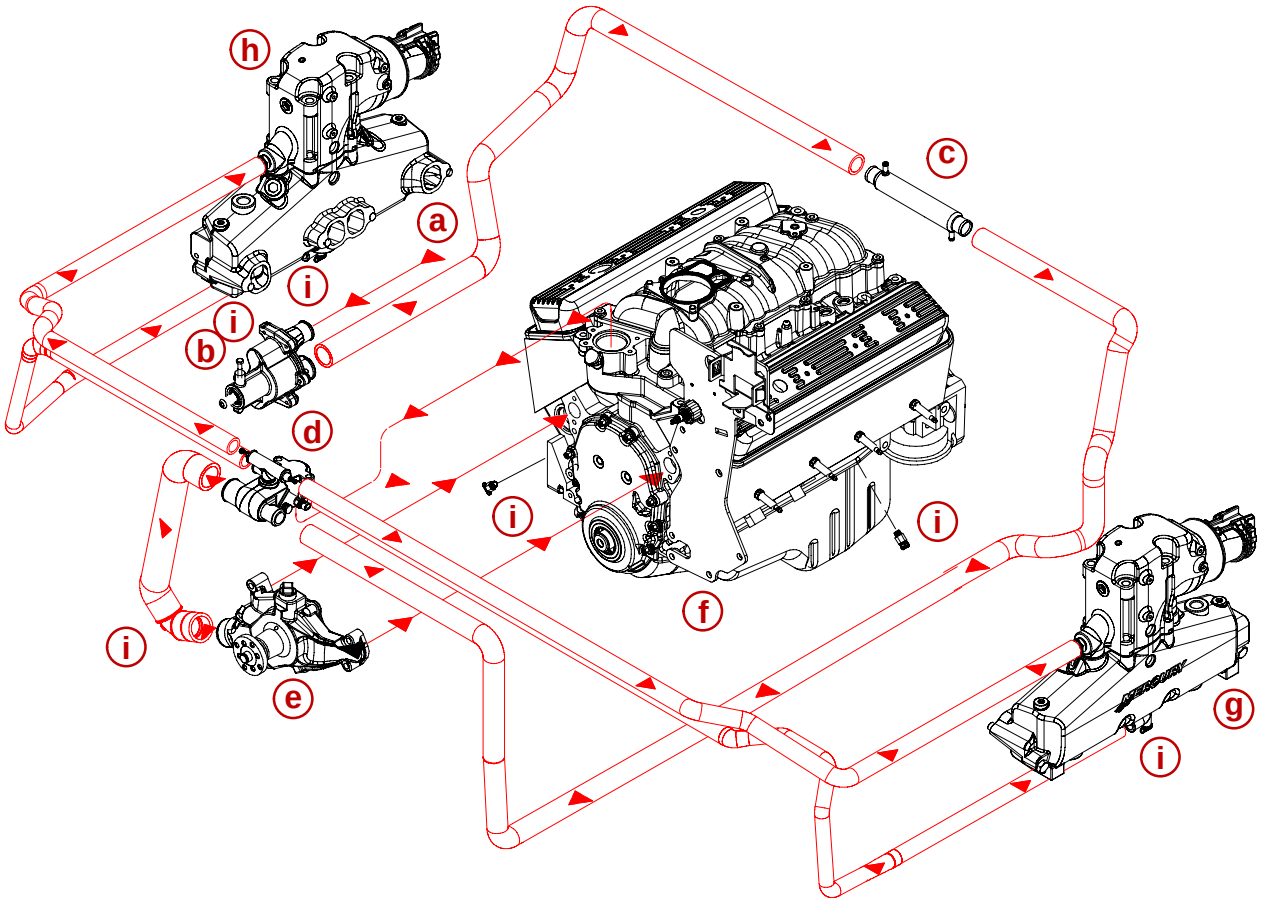
Sterndrive 0M600000 Through 0M614999



79017

a - Seawater inlet
b - Power steering cooler
c - Drain plug
d - Exhaust outlet
e - Exhaust manifold
f - Seawater pump
g - Water circulating pump
h - Thermostat housing
i - Exhaust elbow

Inboard 0M317000 And Above

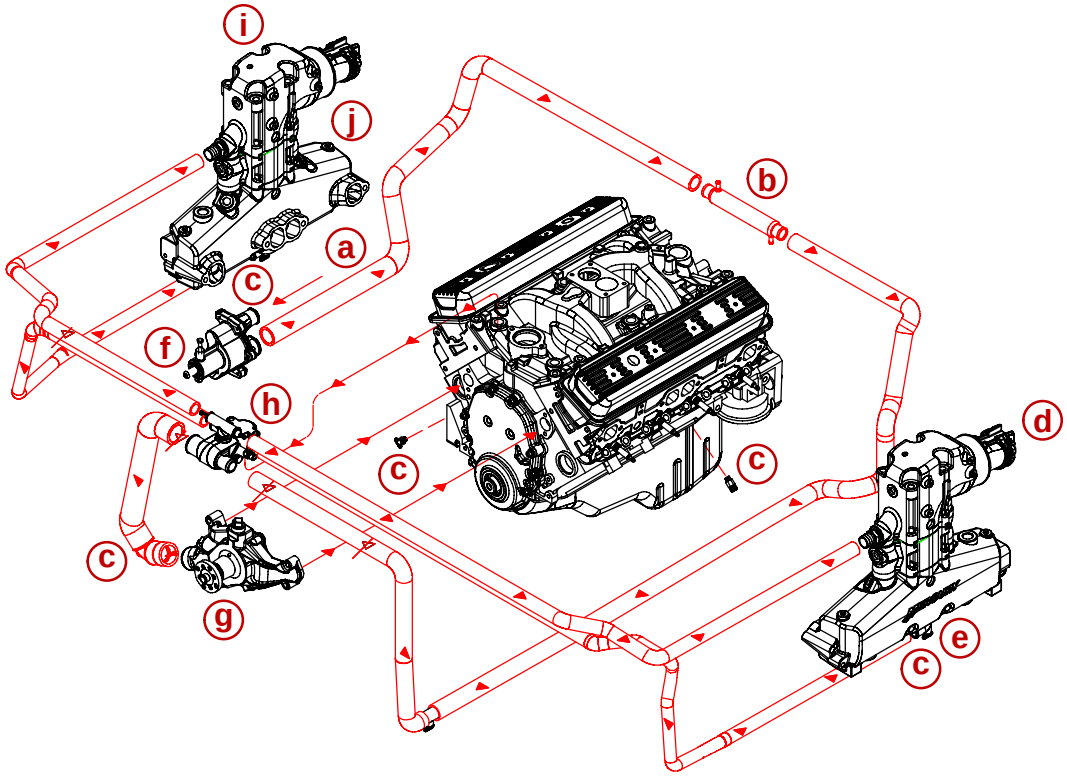


78754

In-line model shown, v-drive similar

- **a** - Seawater inlet
- **b** - Seawater pump
- **c** - Transmission cooler
- **d** - Thermostat housing and cover assembly
- **e** - Engine water circulating pump
- **f** - Engine block and cylinder head assembly
- **g** - Exhaust manifold, typical
- **h** - Exhaust elbow assembly, typical
- **i** - Drain plug

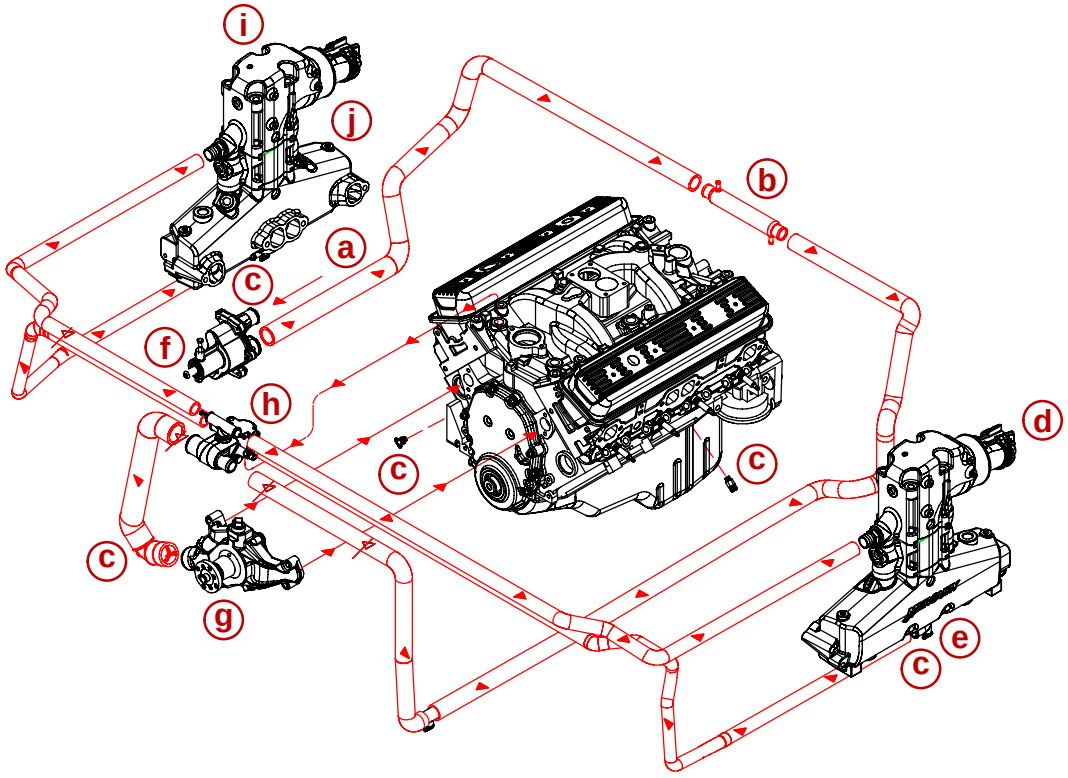
Sterndrive With Risers 0M600000 and Above



79018

a - Seawater inlet
b - Power steering cooler
c - Drain plug
d - Exhaust outlet
e - Exhaust manifold
f - Seawater pump
g - Water circulating pump
h - Thermostat housing
i - Exhaust elbow
j - Exhaust 76 mm (3 in.) riser

In-line Inboard With Risers 0M317000 and Above



79018

In-line shown, v-drive similar

- **a** - Seawater inlet
- **b** - Transmission cooler
- **c** - Drain plug
- **d** - Exhaust outlet
- **e** - Exhaust manifold
- **f** - Seawater pump
- **g** - Water circulating pump
- **h** - Thermostat housing
- **i** - Exhaust elbow
- **j** - Exhaust 76 mm (3 in.) riser

NOTES:

WATER FLOW DIAGRAMS

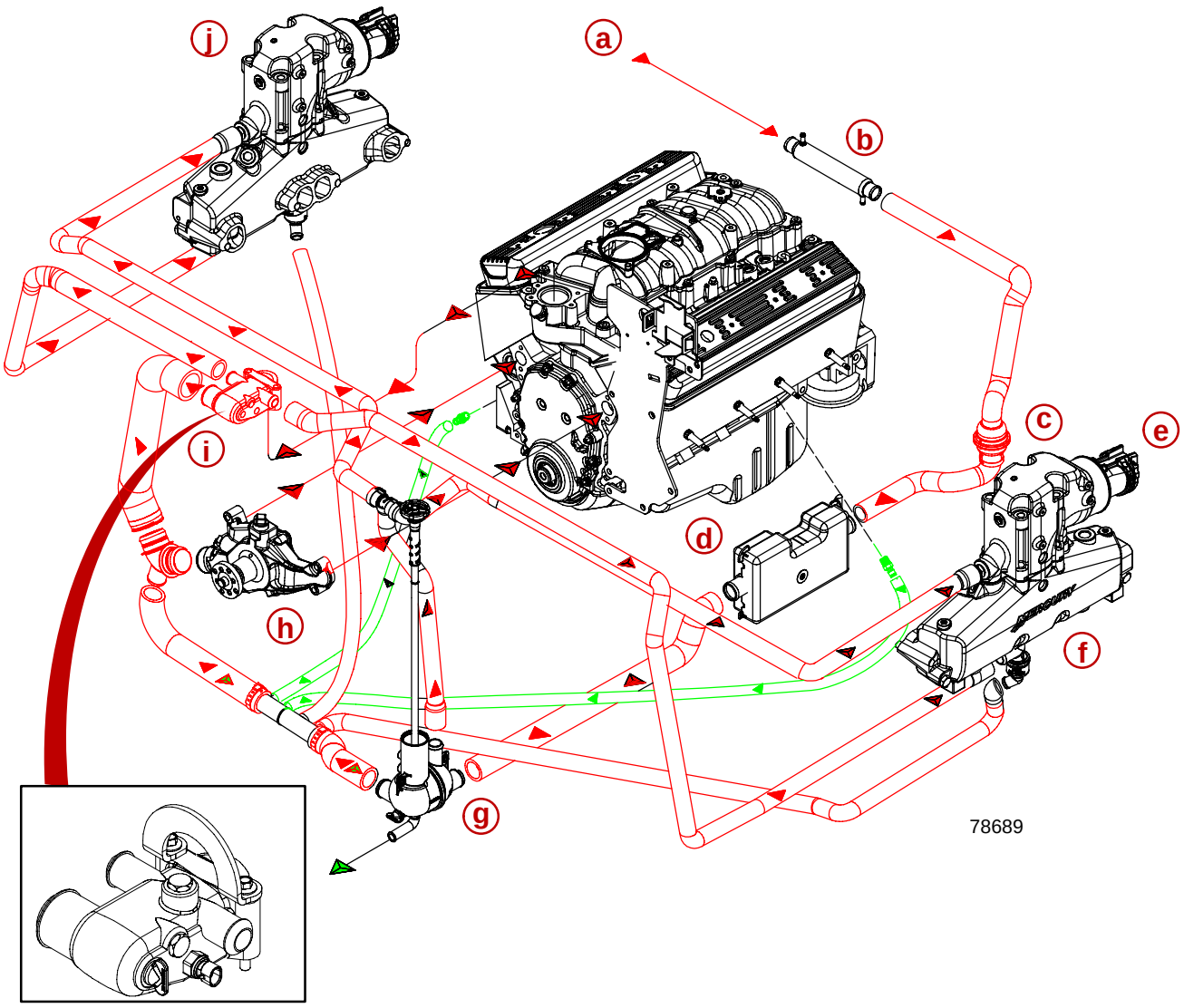
Section 10C - Seawater Cooled MPI Models

Table of Contents

Alpha Models (Excluding MPD) 0M300000 and Above 10C-2
Alpha MPD 0M300000 And Above 10C-3
In-line Inboard 0M317000 Through 0M389999 ..... 10C-4
V-drive Inboard 0M317000 Through 0M389999 ..... 10C-5
Sterndrive (Excluding MPD) With Risers 0M300000 Through 0M614999 ..... 10C-6
In-line Inboard 0M310000 Through 0M389999 ..... 10C-7
V-drive Inboard With Cold Risers 0M317000 Through 0M389999 ..... 10C-8
Sterndrive With Risers 0M615000 and Above 10C-9
In-line Inboard 0M390000 and Above 10C-10
V-drive Inboard With Warm Risers 0M390000 and Above 10C-11

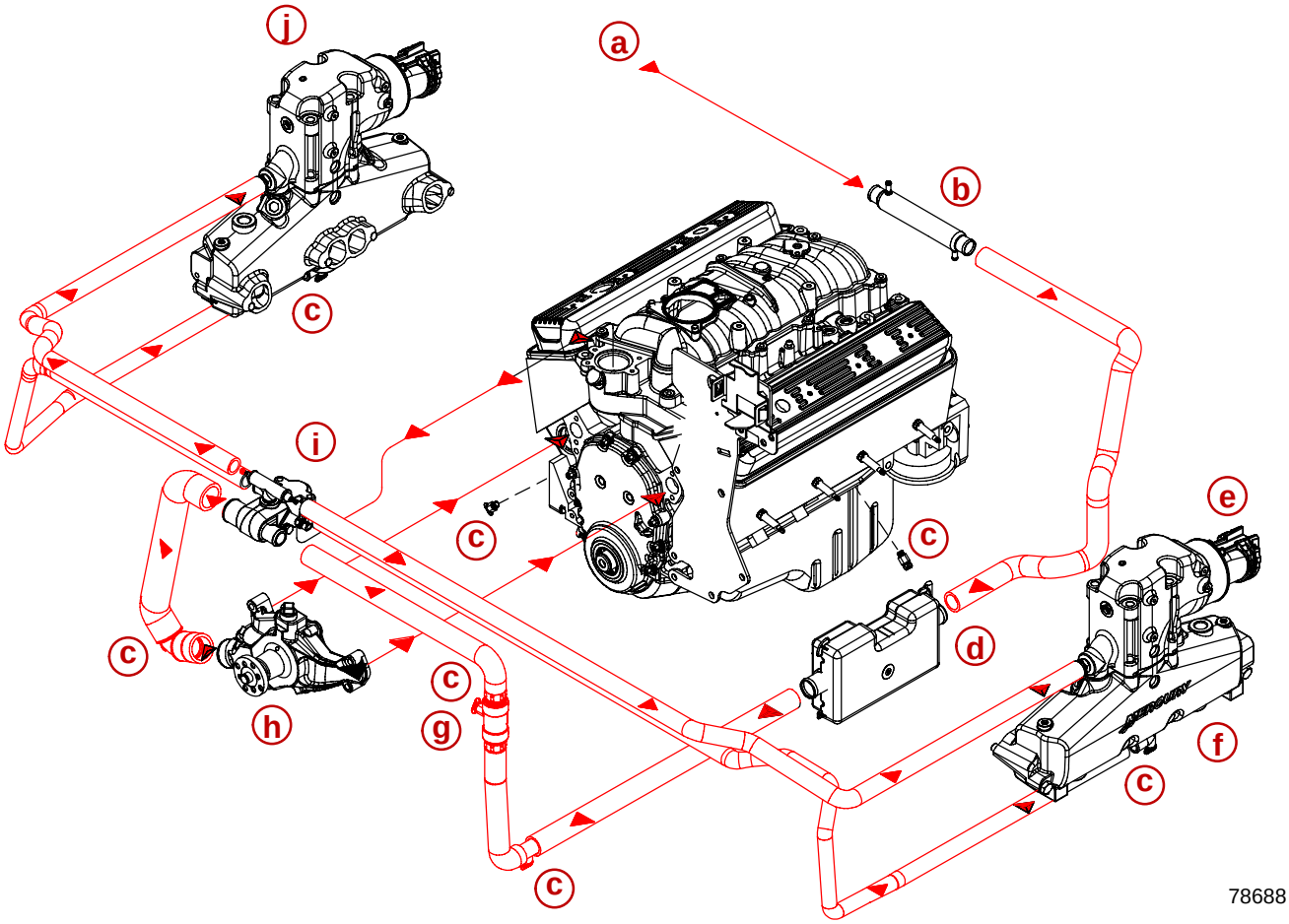
10 C

Alpha Models (Excluding MPD) 0M300000 and Above



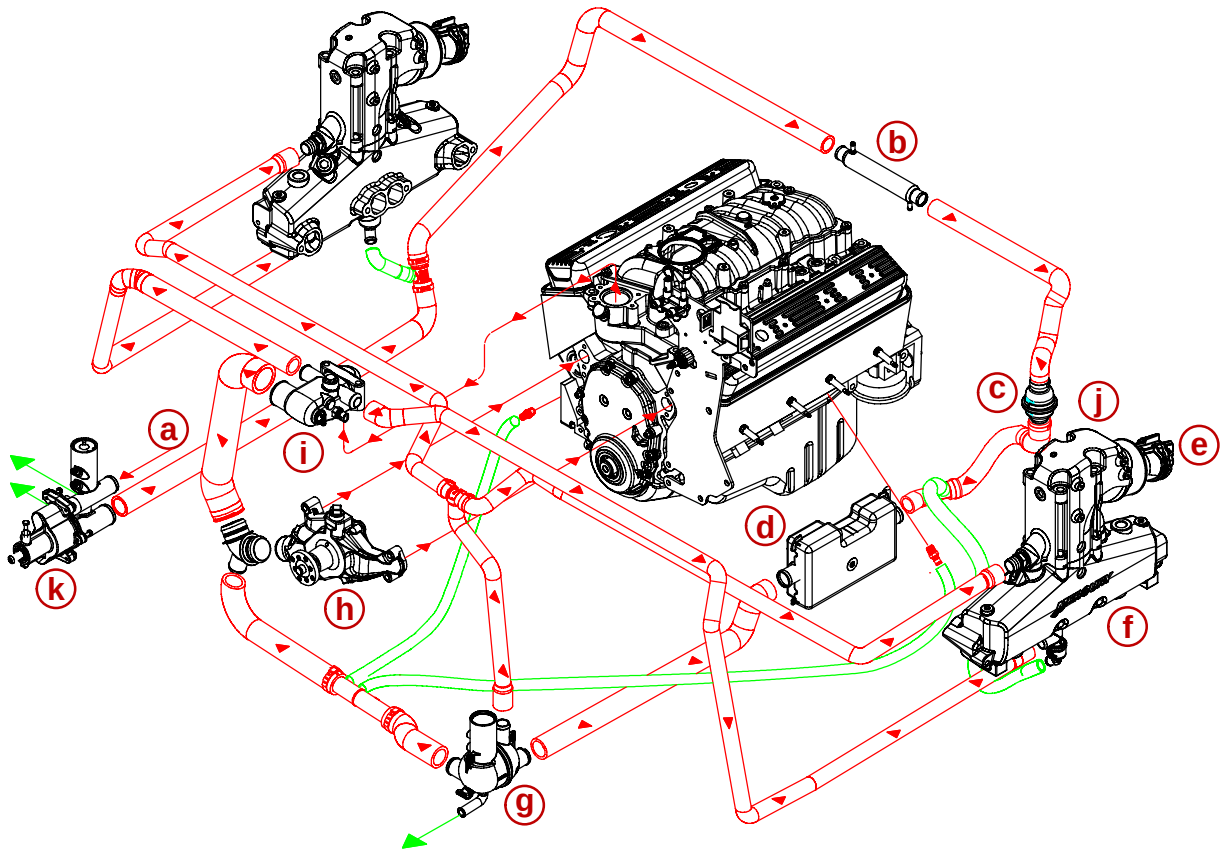
a - Seawater inlet (from transom)
b - Power steering cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - Exhaust elbow

Alpha MPD 0M300000 And Above



a - Seawater inlet (from transom)
b - Power steering cooler
c - Drain plug
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Check valve
h - Water circulating pump
i - Thermostat housing (lifting eye bracket not shown)
j - Exhaust elbow

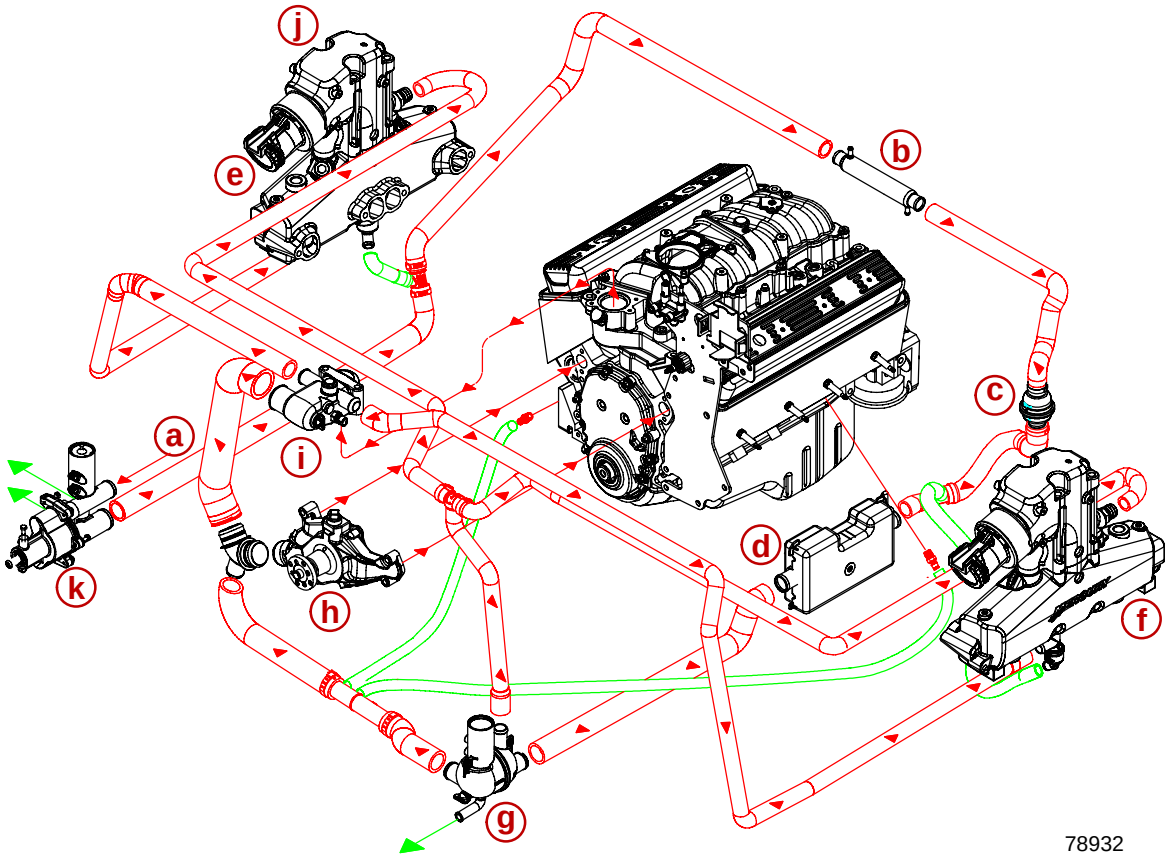
In-line Inboard 0M317000 Through 0M389999



78933

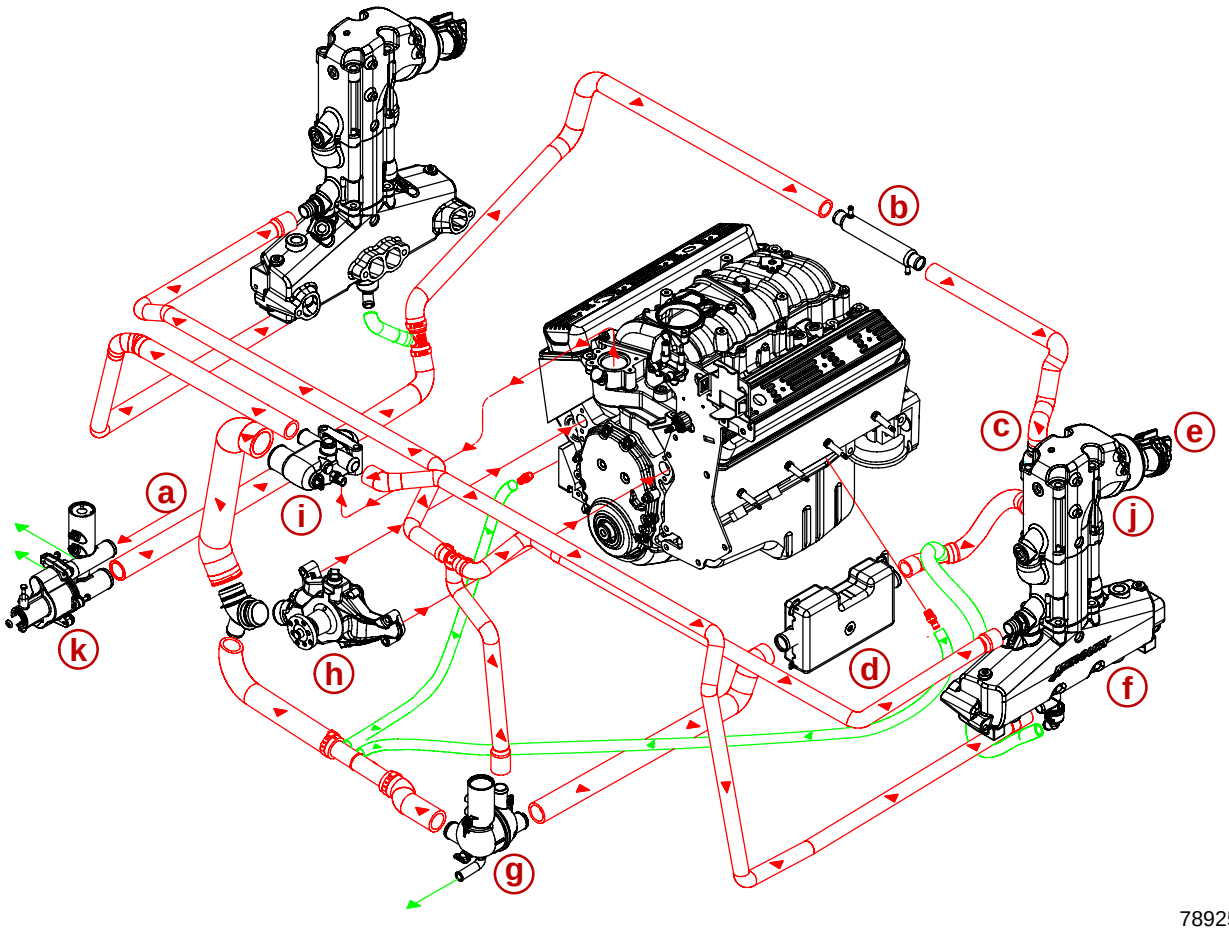
a - Seawater inlet
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - Exhaust elbow
k - Seawater pump

V-drive Inboard 0M317000 Through 0M389999



a - Seawater inlet
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - Exhaust elbow
k - Seawater pump

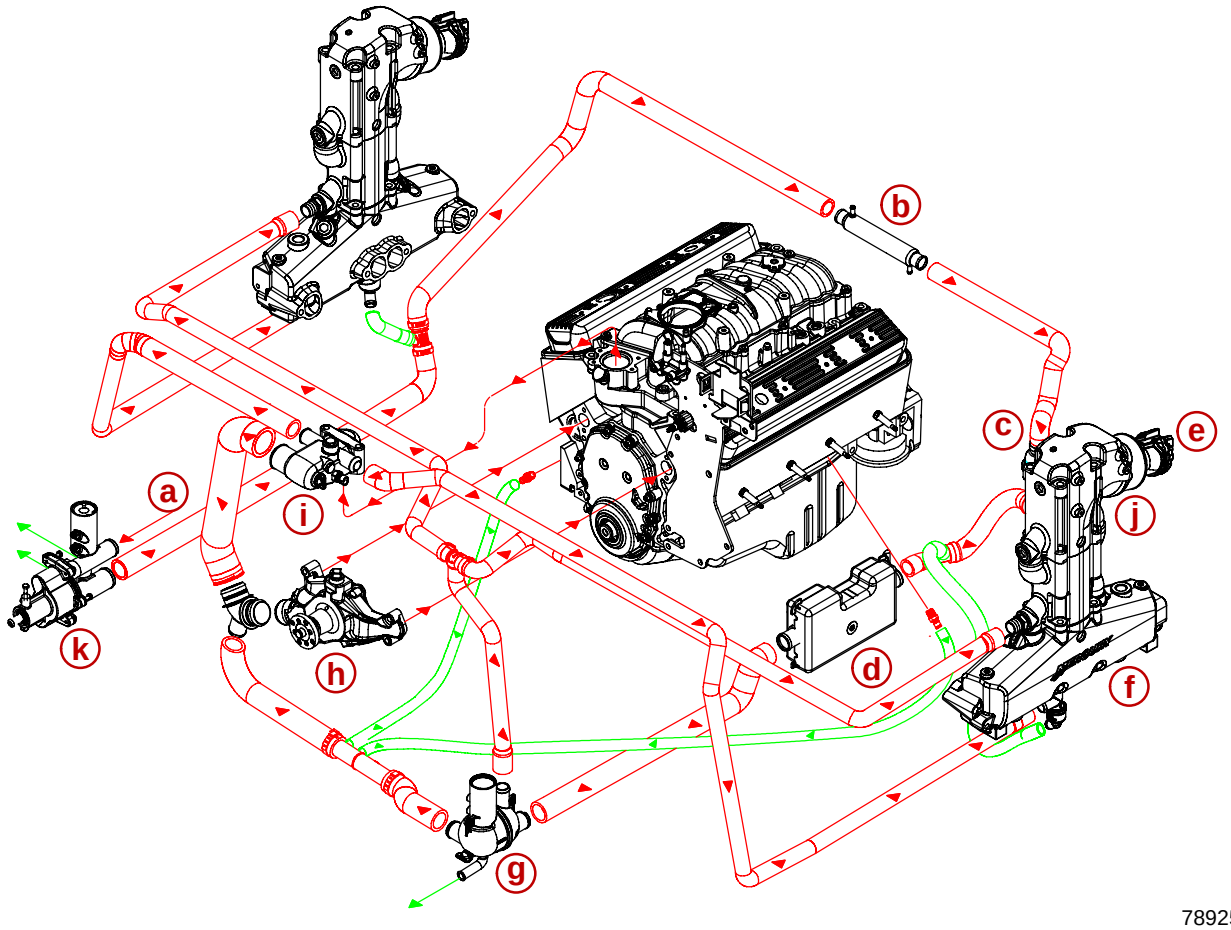
Sterndrive (Excluding MPD) With Risers 0M300000 Through 0M614999



78925

a - Seawater inlet
b - Power steering cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - 14 degree inboard exhaust elbow shown (7 degree similar)
k - Seawater pump (Bravo only)

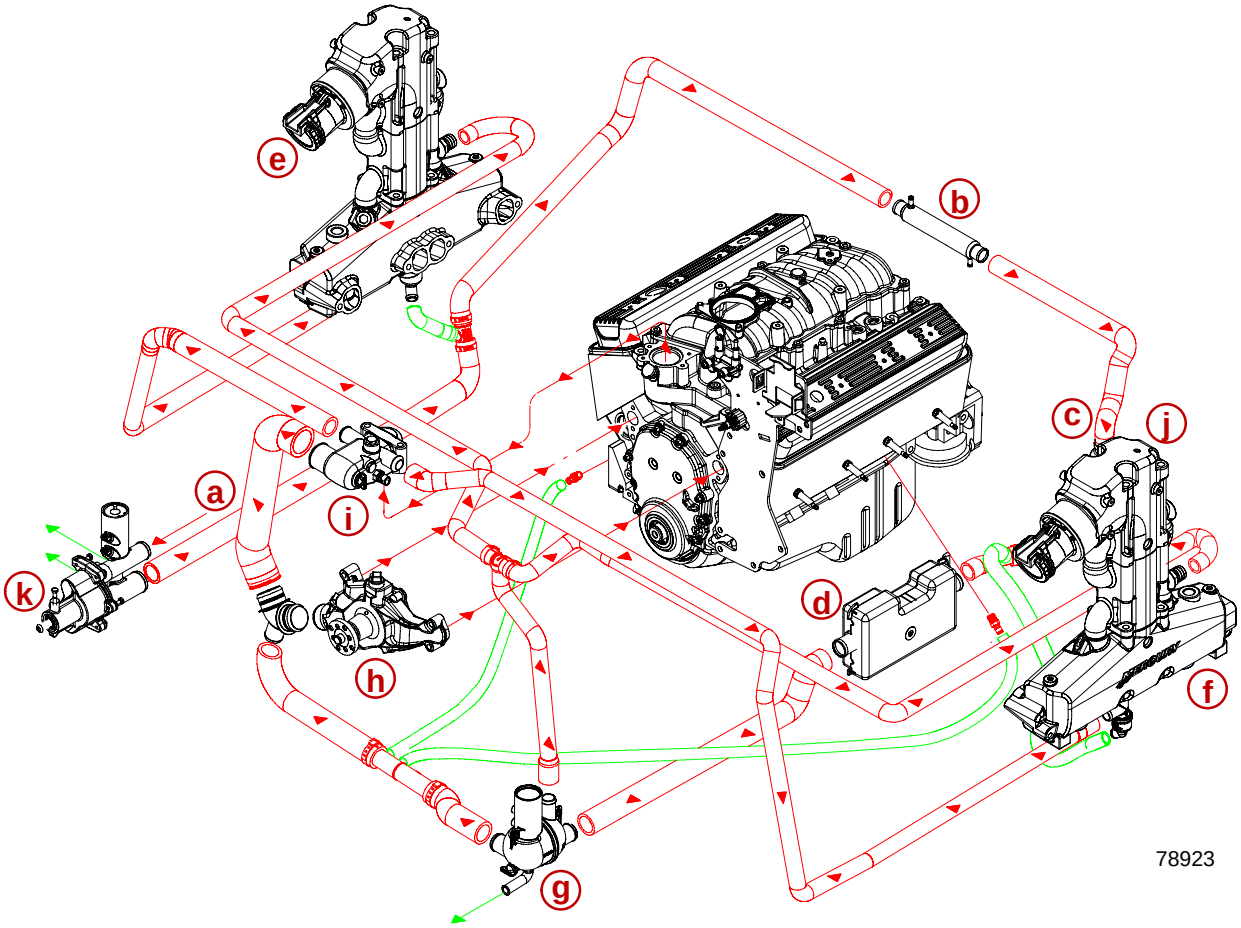
In-line Inboard 0M310000 Through 0M389999



78925

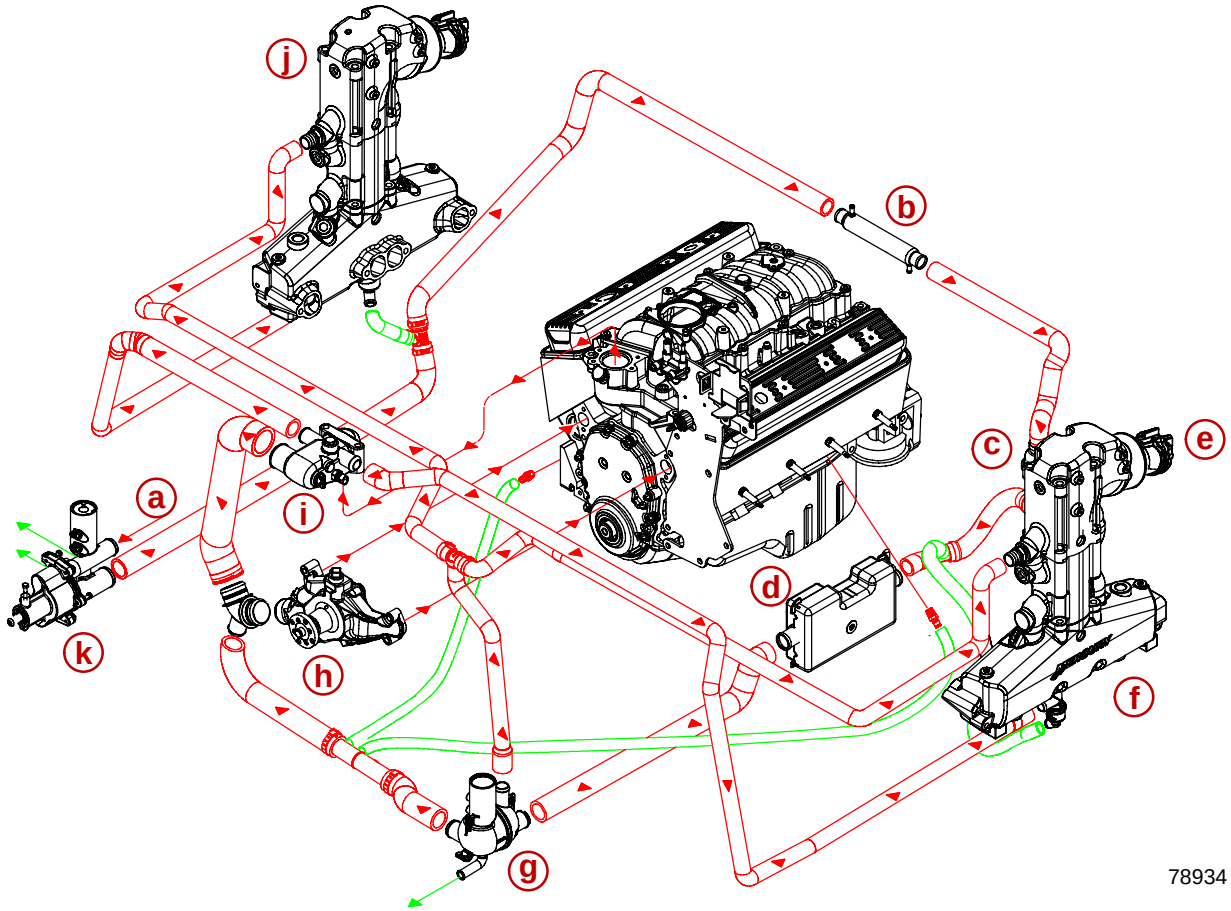
a - Seawater inlet
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - 14 degree exhaust elbow
k - Seawater pump

V-drive Inboard With Cold Risers 0M317000 Through 0M389999



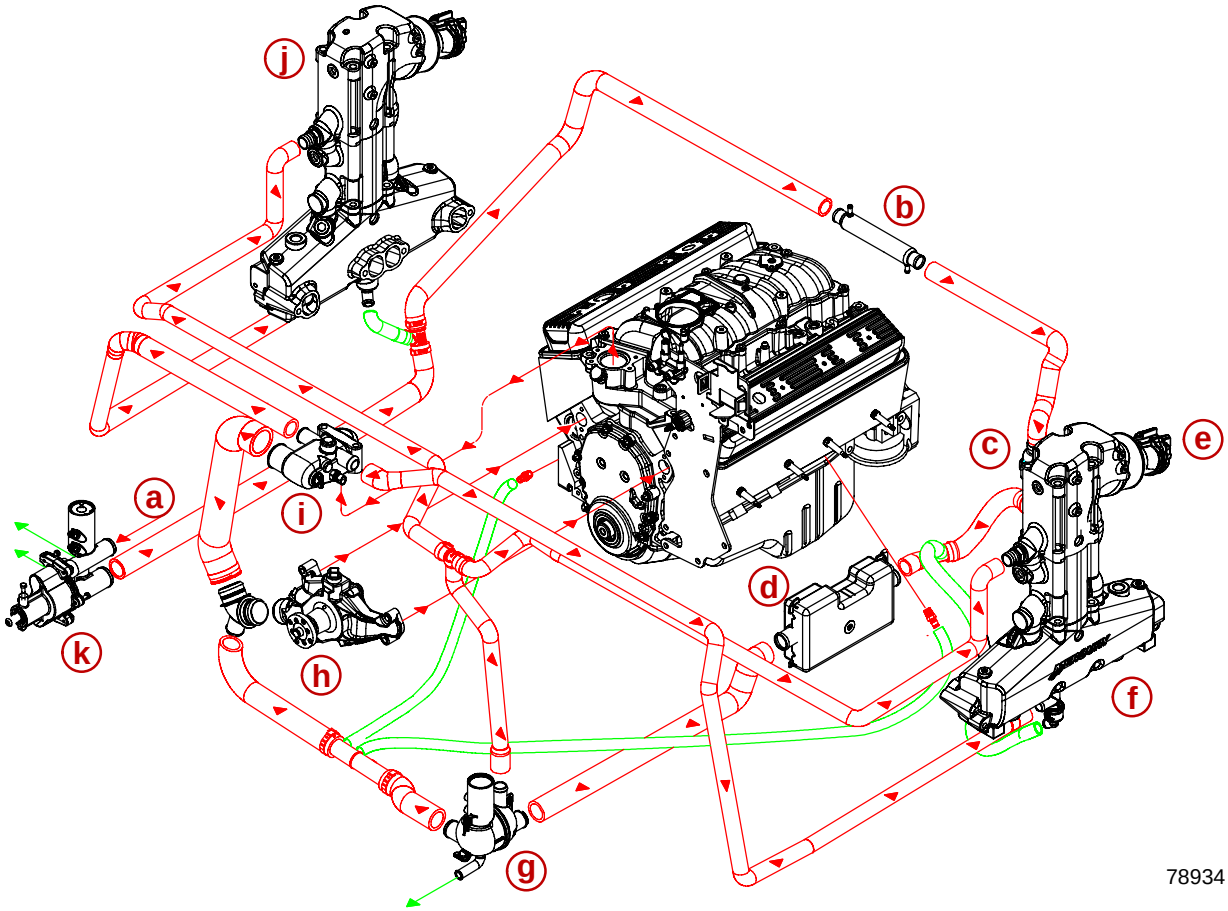
a - Seawater inlet
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - Exhaust elbow
k - Seawater pump

Sterndrive With Risers 0M615000 and Above



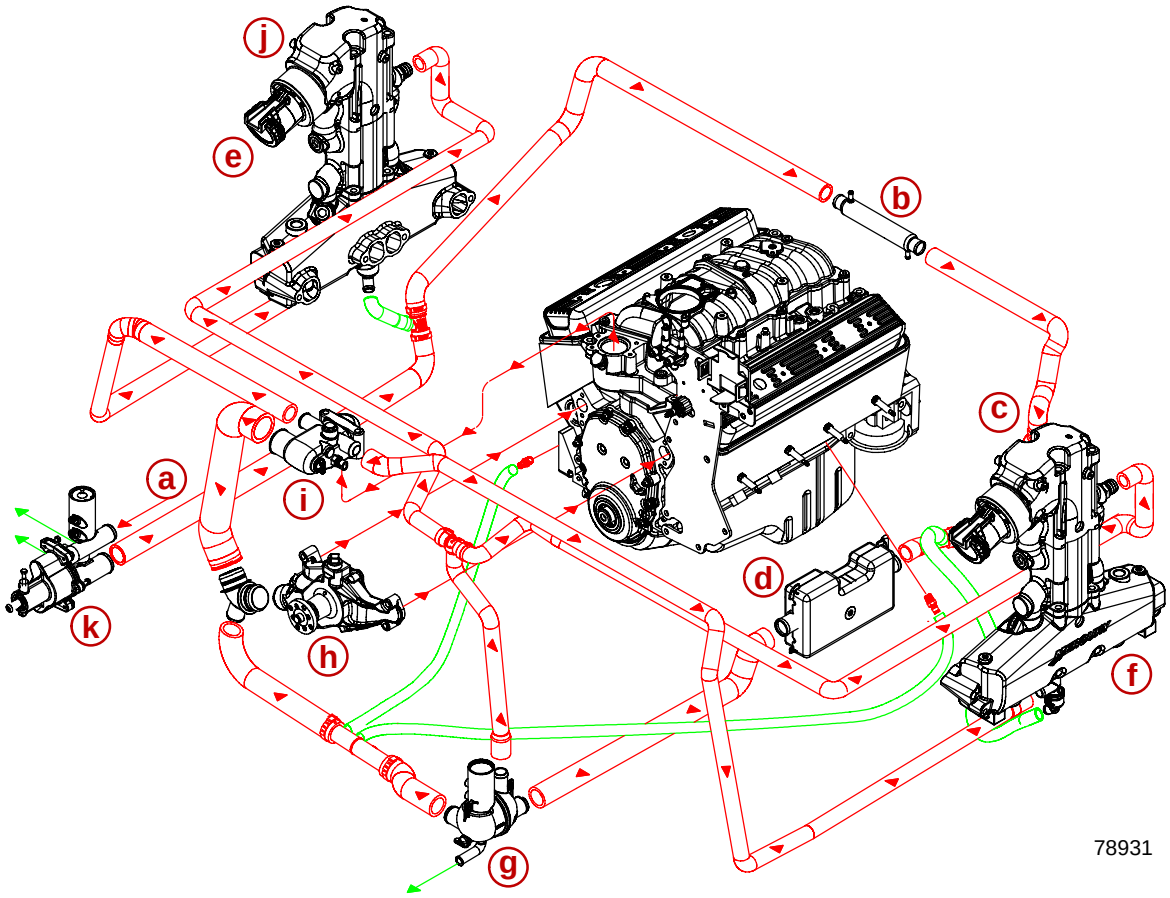
a - Seawater inlet
b - Power steering cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - 14 degree inboard exhaust elbow shown (7 degree similar)
k - Seawater pump (Bravo only)

In-line Inboard 0M390000 and Above



a - Seawater inlet
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - 14 degree exhaust elbow
k - Seawater pump

V-drive Inboard With Warm Risers 0M390000 and Above



a - Seawater inlet
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - Exhaust elbow
k - Seawater pump

NOTES:

WATER FLOW DIAGRAMS

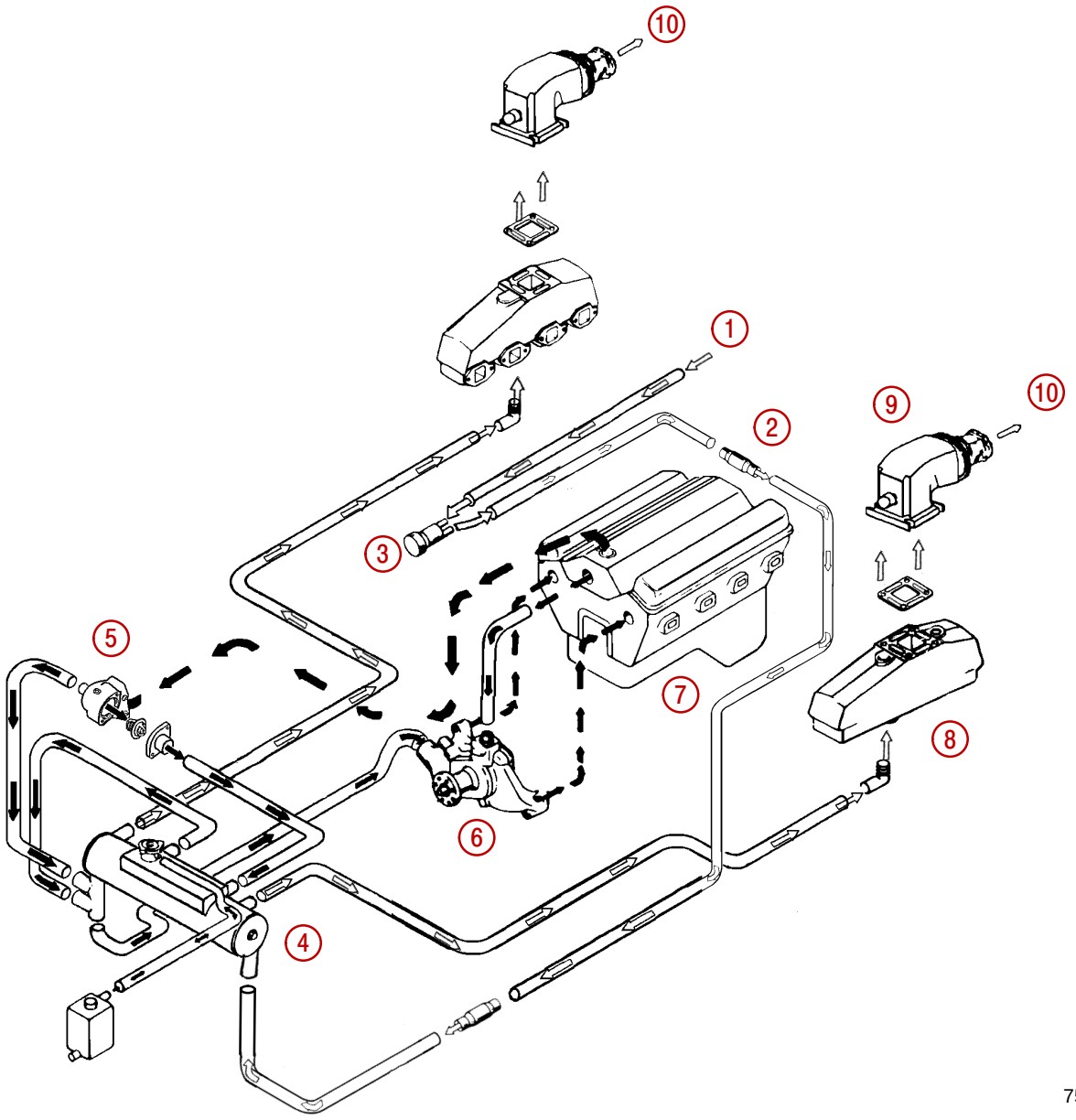
Section 10D - Closed Cooled Carbureted Models

Table of Contents

Sterndrive 0M599999 And Below 10D-2
Inboard 0M316999 And Below 10D-3
Sterndrive 0M600000 And Above 10D-4
Inboard 0M600000 And Above 10D-5

10 D

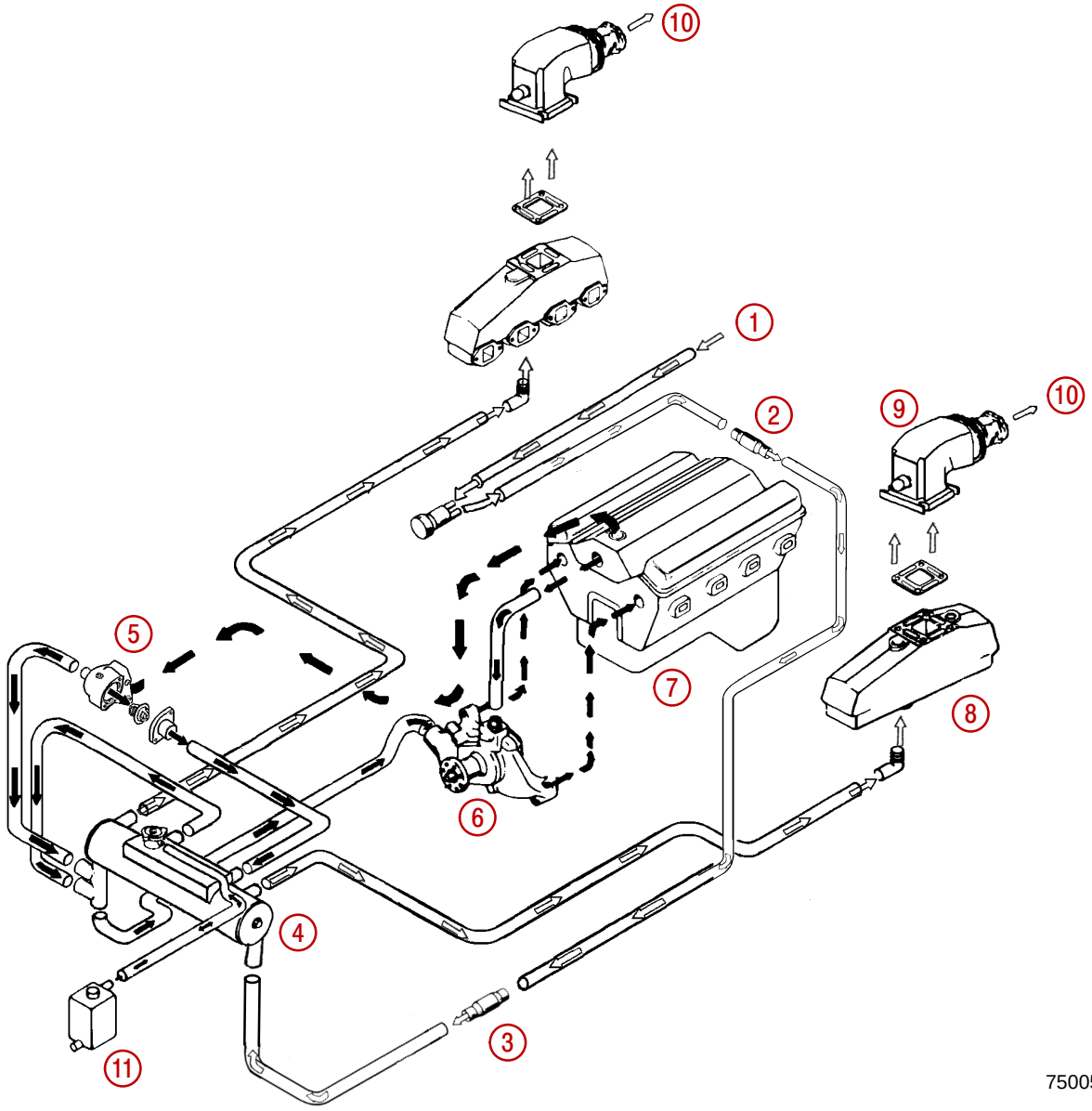
Sterndrive 0M599999 And Below



1 - Seawater Intake (From Sterndrive)
2 - Power Steering Cooler
3 - Seawater pump
4 - Heat Exchanger, Typical
5 - Thermostat Housing and Cover Assembly
6 - Engine Water Circulating Pump
7 - Engine Block and Cylinder Head Assembly
8 - Exhaust Manifold, Typical
9 - Exhaust Elbow Assembly, Typical
10 - Overboard (Water and Exhaust Discharge)

Inboard 0M316999 And Below

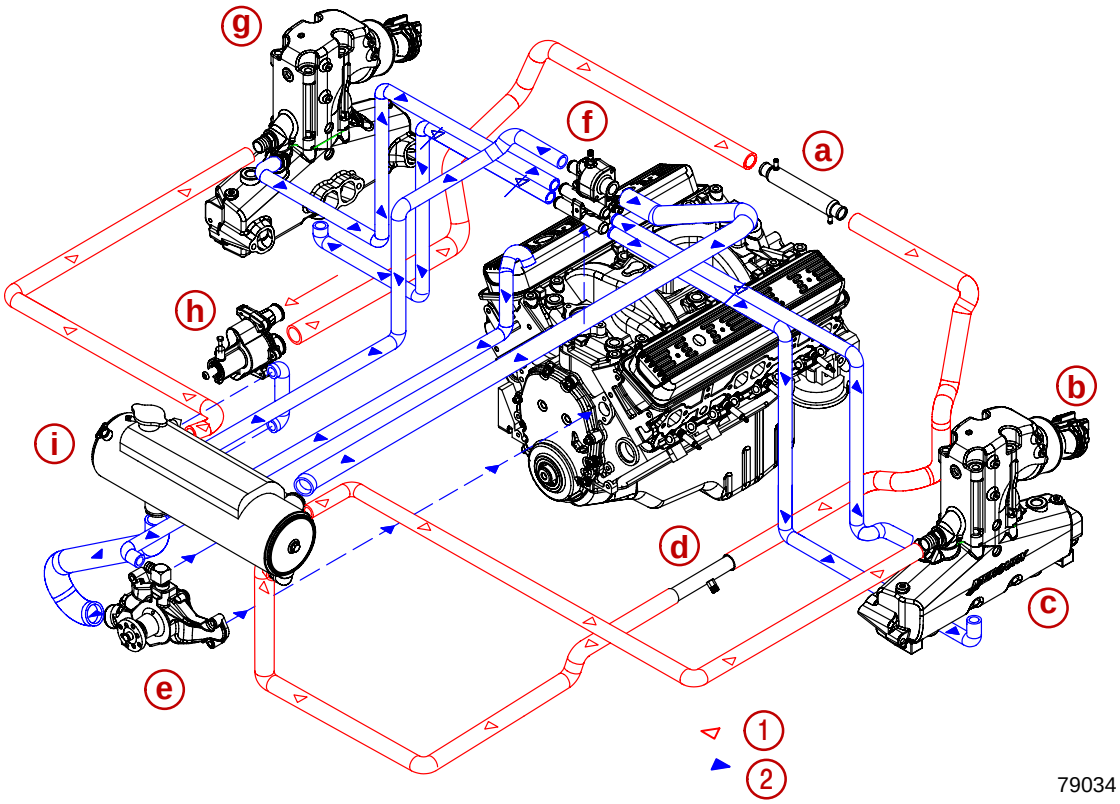
NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



Inline shown, v-drive similar

1 - Seawater Intake (From Sterndrive)
2 - Transmission Cooler
3 - Fuel Cooler (EFI Models)
4 - Heat Exchanger, Typical
5 - Thermostat Housing and Cover Assembly
6 - Engine Water Circulating Pump
7 - Engine Block and Cylinder Head Assembly
8 - Exhaust Manifold, Typical
9 - Exhaust Elbow Assembly, Typical
10 - Overboard (Water and Exhaust Discharge)
11 - Coolant Recovery Bottle

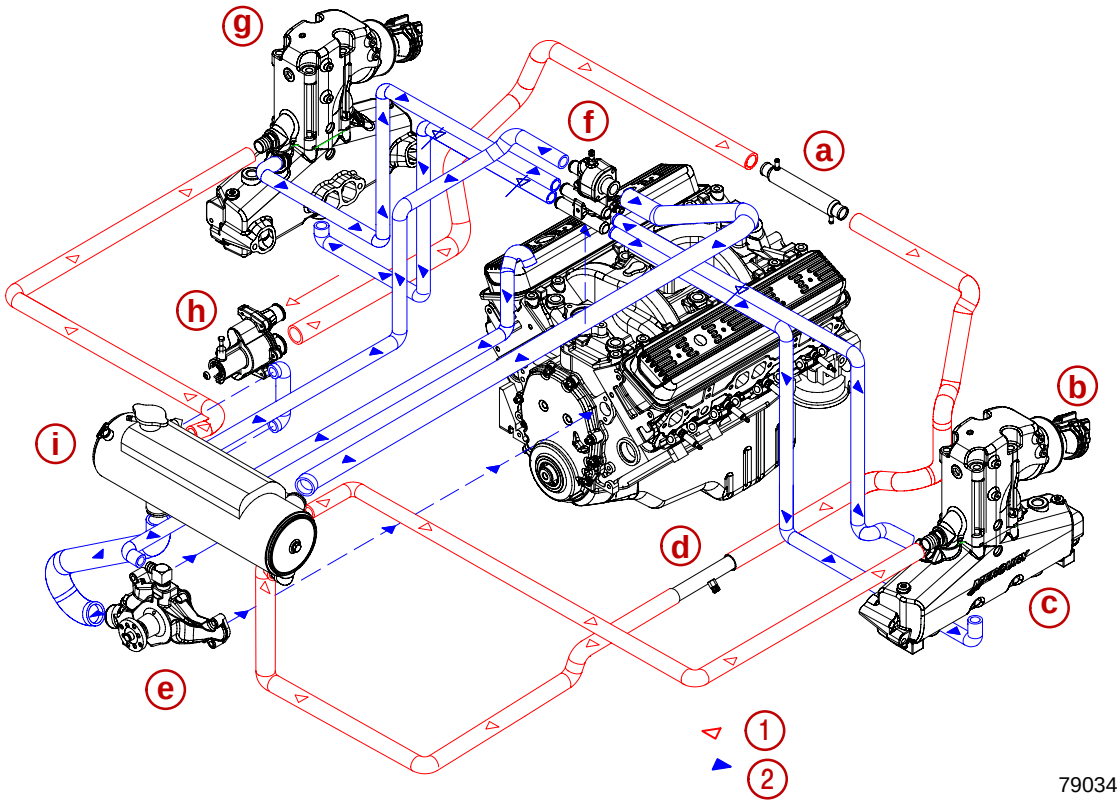
Sterndrive 0M600000 And Above



a - Power steering cooler
b - Exhaust and seawater outlet
c - Exhaust manifold
d - Adaptor tube
e - Water circulating pump
f - Thermostat housing
g - Exhaust elbow
h - Seawater pump
i - Heat exchanger

1 - Seawater
2 - Ethylene glycol mix

Inboard 0M600000 And Above



In-line shown, v-drive similar

- **a** - Transmission cooler
- **b** - Exhaust and seawater outlet
- **c** - Exhaust manifold
- **d** - Adaptor tube
- **e** - Water circulating pump
- **f** - Thermostat housing
- **g** - Exhaust elbow
- **h** - Seawater pump
- **i** - Heat exchanger

- **1** - Seawater
- **2** - Ethylene glycol mix

NOTES:

WATER FLOW DIAGRAMS

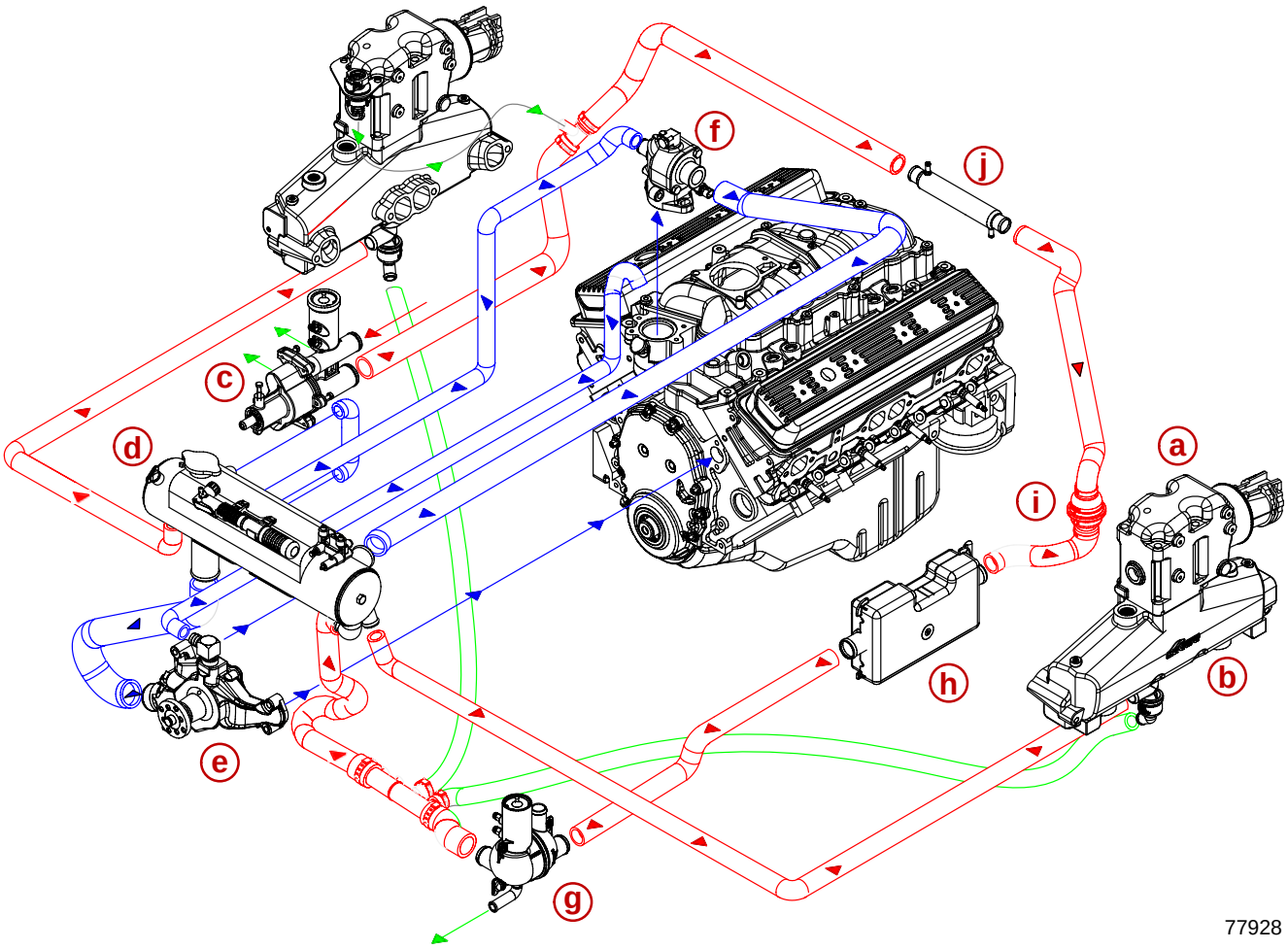
Section 10E - Closed Cooled MPI Models

Table of Contents

Sterndrive 0M300000 Through 0M599999 ..... 10E-2
Sterndrive 0M600000 And Above 10E-3
Inline Inboard 0M310000 Through 0M316999 ..... 10E-3
V-drive Inboard 0M317000 Through 0M389999 ..... 10E-5
Inline Inboard 0M317000 And Above .. 10E-6
Inboard With Risers 0M317000 And Above 10E-7
Inline Inboard 0M310000 Through 0M389999 ..... 10E-8
Sterndrive With Cold Risers 0M600000 Through 0M614999 ..... 10E-9
Inline Inboard With Cold Risers 0M317000 Through 0M389999 ..... 10E-10
V-drive Inboard With Cold Risers 0M317000 Through 0M389999 ..... 10E-11
Sterndrive With Warm Risers 0M615000 and Above 10E-12
Inline Inboard With Warm Risers 0M390000 and Above 10E-13
V-drive Inboard With Warm Risers 0M390000 and Above 10E-14

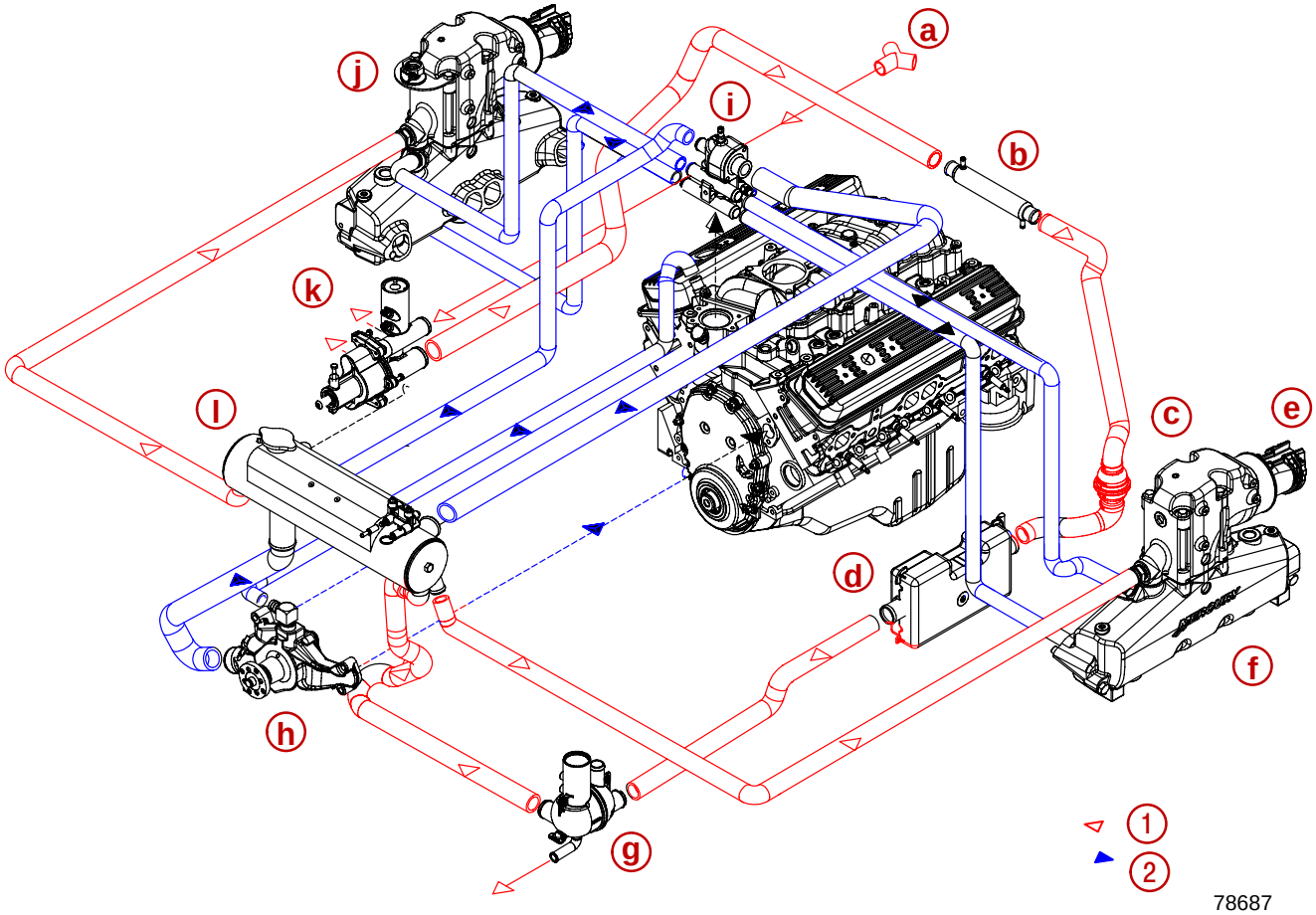
10 E

Sterndrive 0M300000 Through 0M599999



a - Exhaust elbow
b - Exhaust manifold
c - Seawater pump
d - Heat exchanger
e - Water circulating pump
f - Thermostat housing
g - Water distribution housing
h - Fuel cooler
i - Check valve
j - Power steering cooler

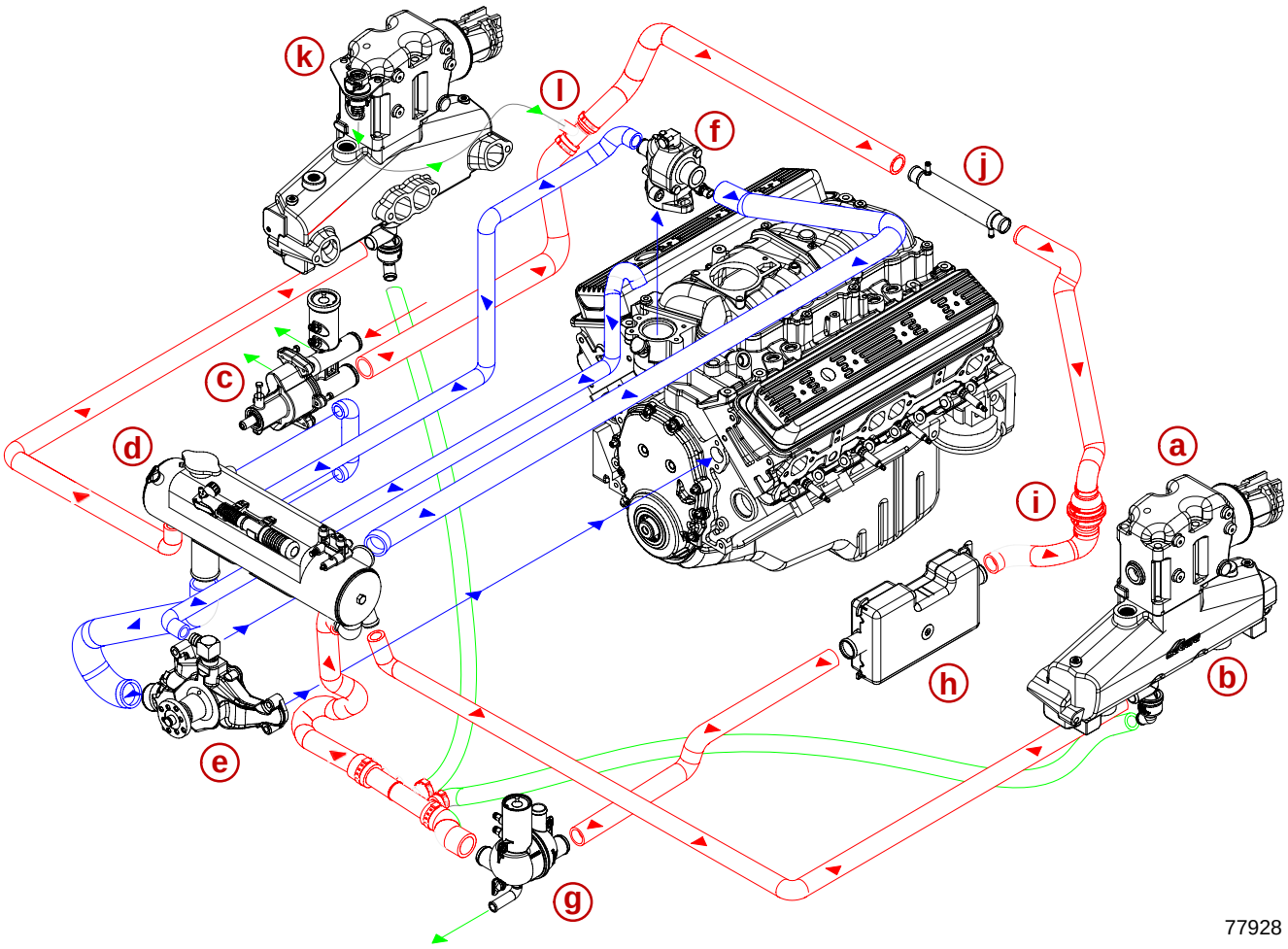
Sterndrive 0M600000 And Above



a - Y-fitting (Bravo models only)
b - Power steering cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - Exhaust elbow
k - Seawater pump
l - Heat exchanger

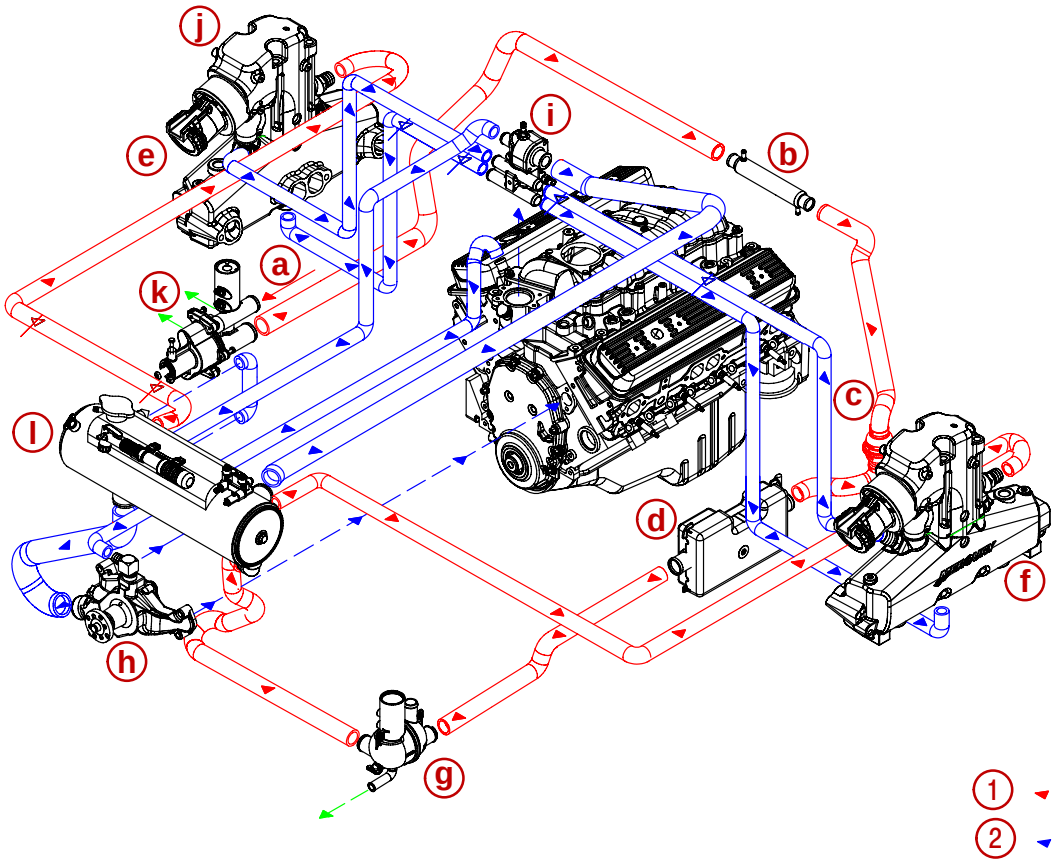
1 - Seawater
2 - Ethylene glycol mix

Inline Inboard 0M310000 Through 0M316999



a - Exhaust elbow
b - Exhaust manifold
c - Seawater pump (not on Alpha models)
d - Heat exchanger
e - Water circulating pump
f - Thermostat housing
g - Water distribution housing
h - Fuel cooler
i - Check valve
j - Power steering or transmission cooler
k - Flush fitting (inboard models)
l - Flush connection (inboard models)

V-drive Inboard 0M317000 Through 0M389999

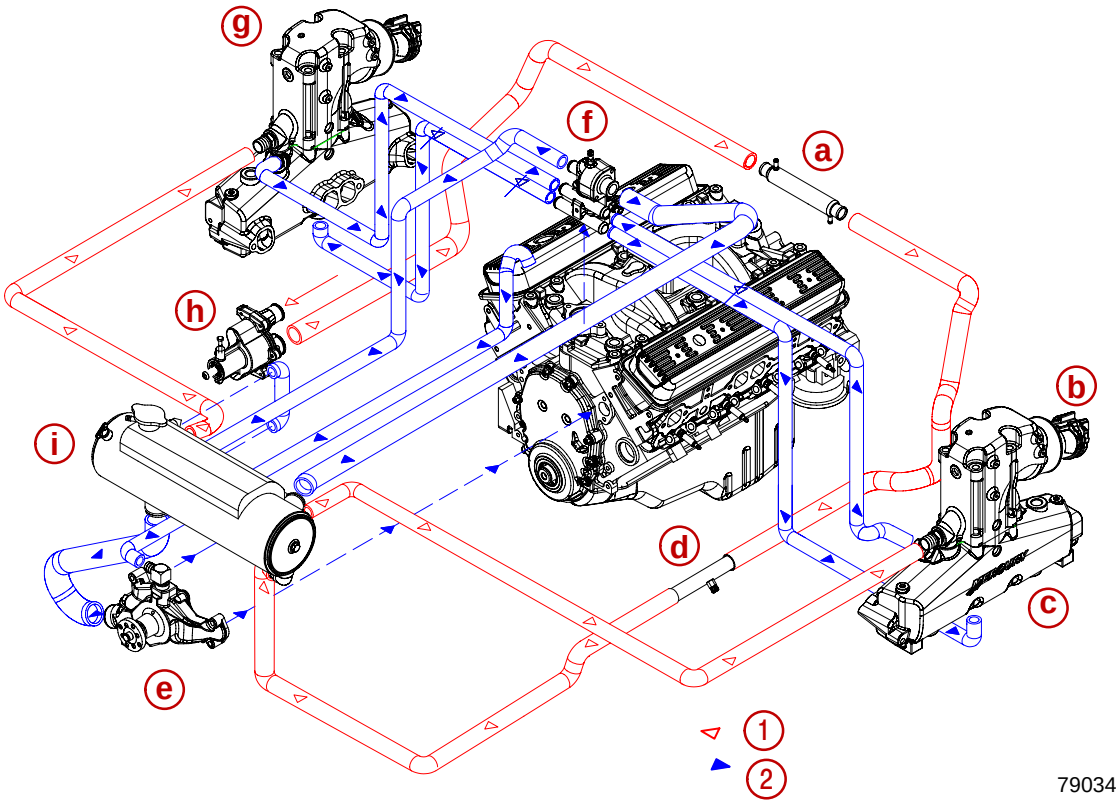


78928

a - Seawater inlet
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - Exhaust elbow
k - Seawater pump
l - Heat exchanger

1 - Seawater
2 - Ethylene glycol mix

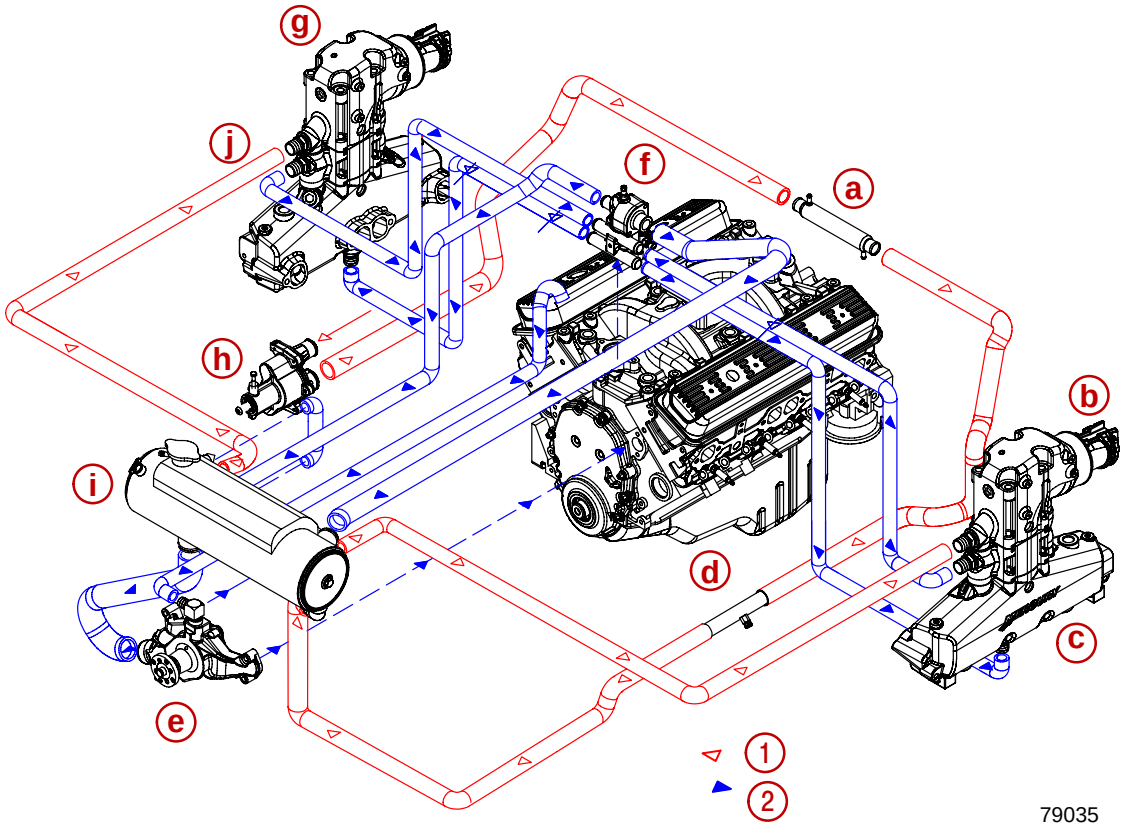
Inline Inboard 0M317000 And Above



a - Transmission cooler
b - Exhaust and seawater outlet
c - Exhaust manifold
d - Adaptor tube
e - Water circulating pump
f - Thermostat housing
g - Exhaust elbow
h - Seawater pump
i - Heat exchanger

1 - Seawater
2 - Ethylene glycol mix

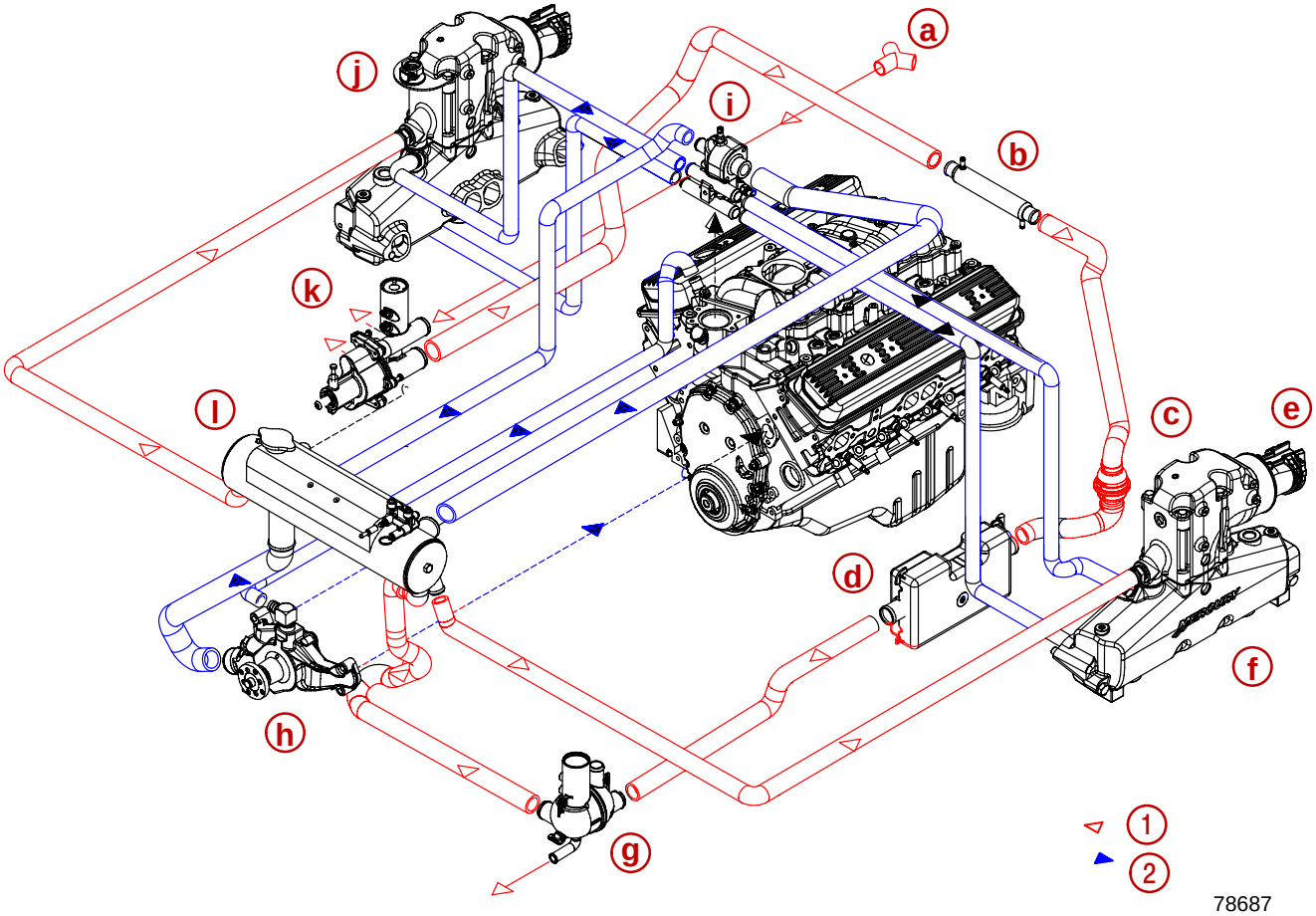
Inboard With Risers 0M317000 And Above



a - Transmission cooler
b - Exhaust and seawater outlet
c - Exhaust manifold
d - Adaptor tube
e - Water circulating pump
f - Thermostat housing
g - Exhaust elbow
h - Seawater pump
i - Heat exchanger
j - 76 mm (3 in.) riser

1 - Seawater
2 - Ethylene glycol mix

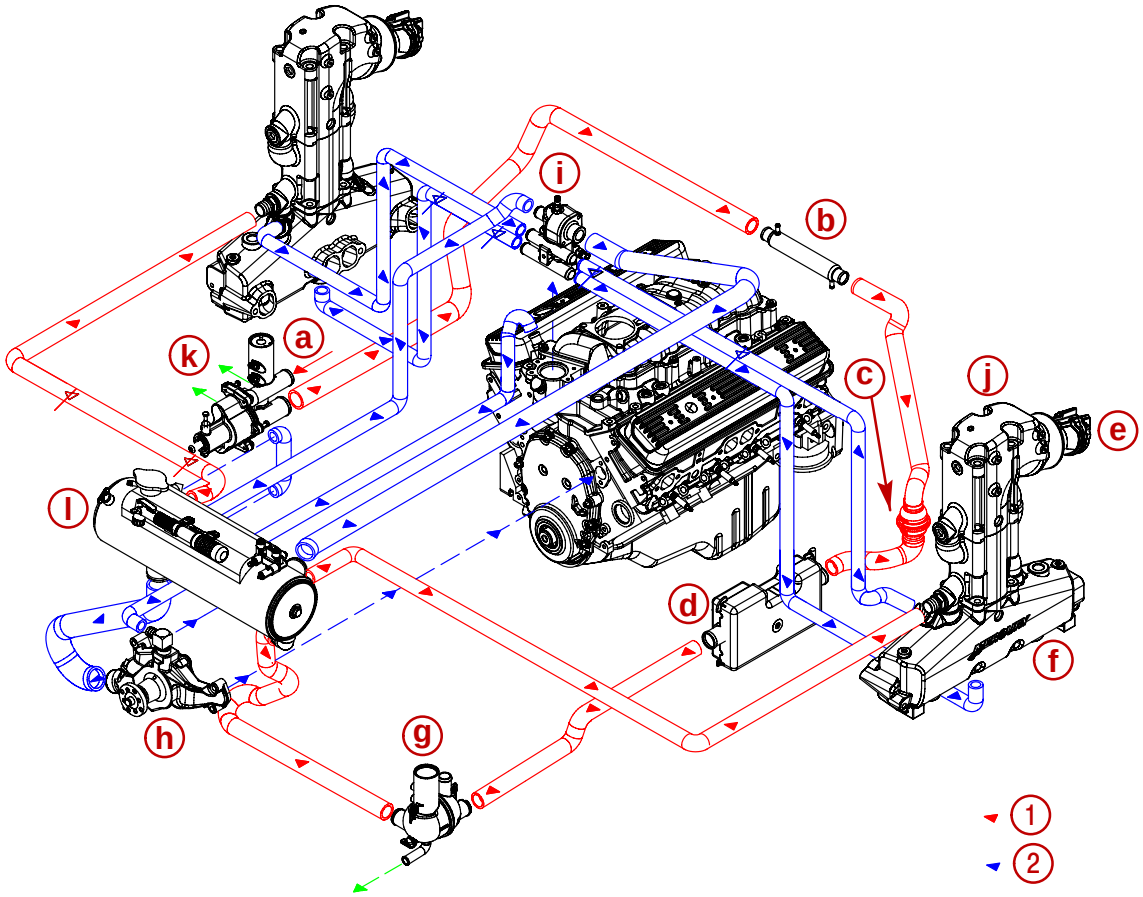
Inline Inboard 0M310000 Through 0M389999



a - Y-fitting (Bravo models only)
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - Exhaust elbow
k - Seawater pump
l - Heat exchanger

1 - Seawater
2 - Ethylene glycol mix

Sterndrive With Cold Risers 0M600000 Through 0M614999

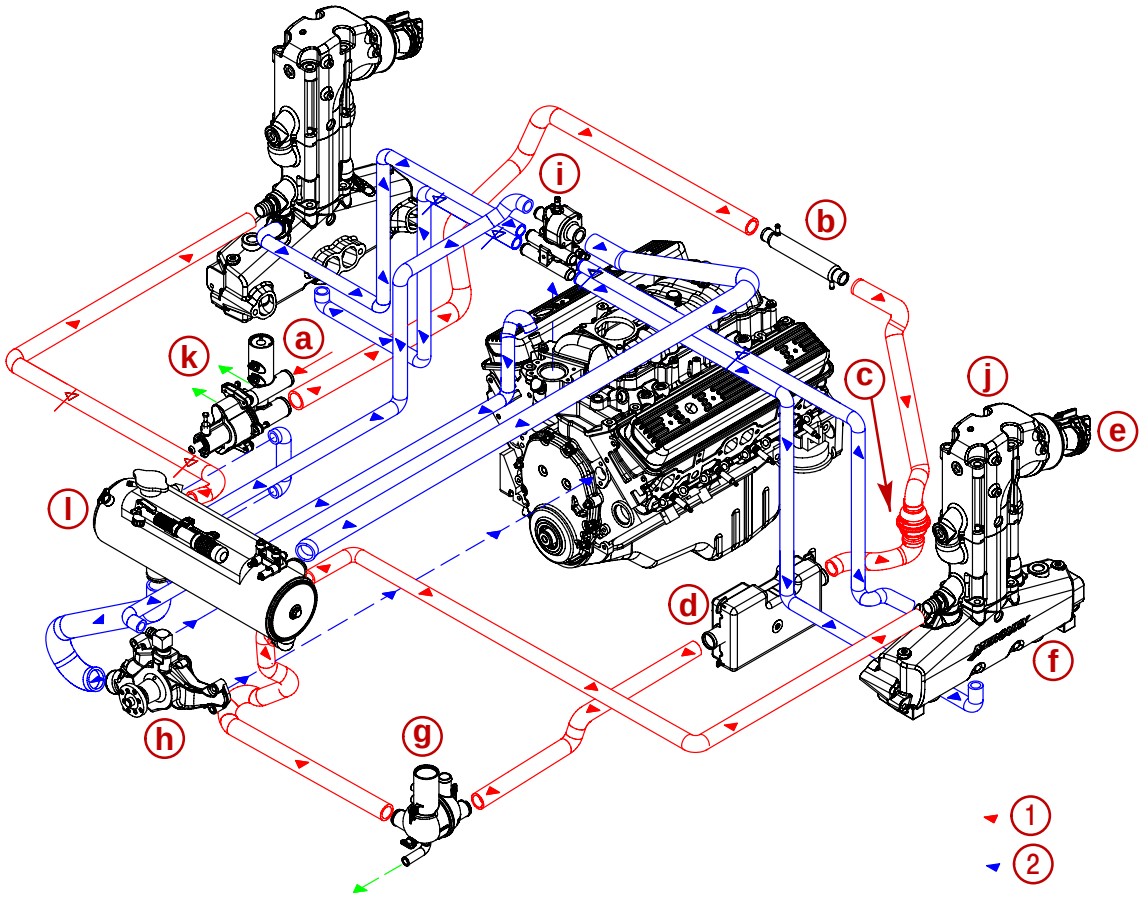


78924

a - Seawater inlet
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - 14 degree exhaust elbow
k - Seawater pump
l - Heat exchanger

1 - Seawater
2 - Ethylene glycol mix

Inline Inboard With Cold Risers 0M317000 Through 0M389999

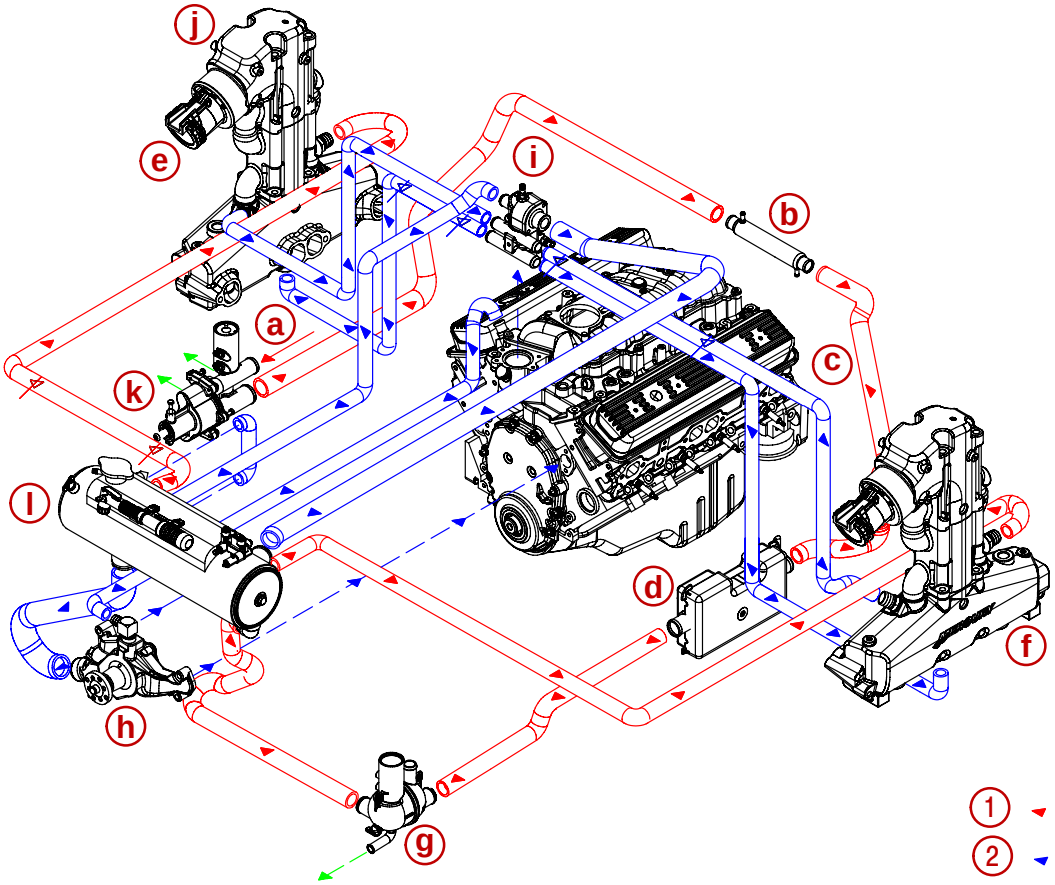


78924

a - Seawater inlet
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - 14 degree exhaust elbow
k - Seawater pump
l - Heat exchanger

1 - Seawater
2 - Ethylene glycol mix

V-drive Inboard With Cold Risers 0M317000 Through 0M389999

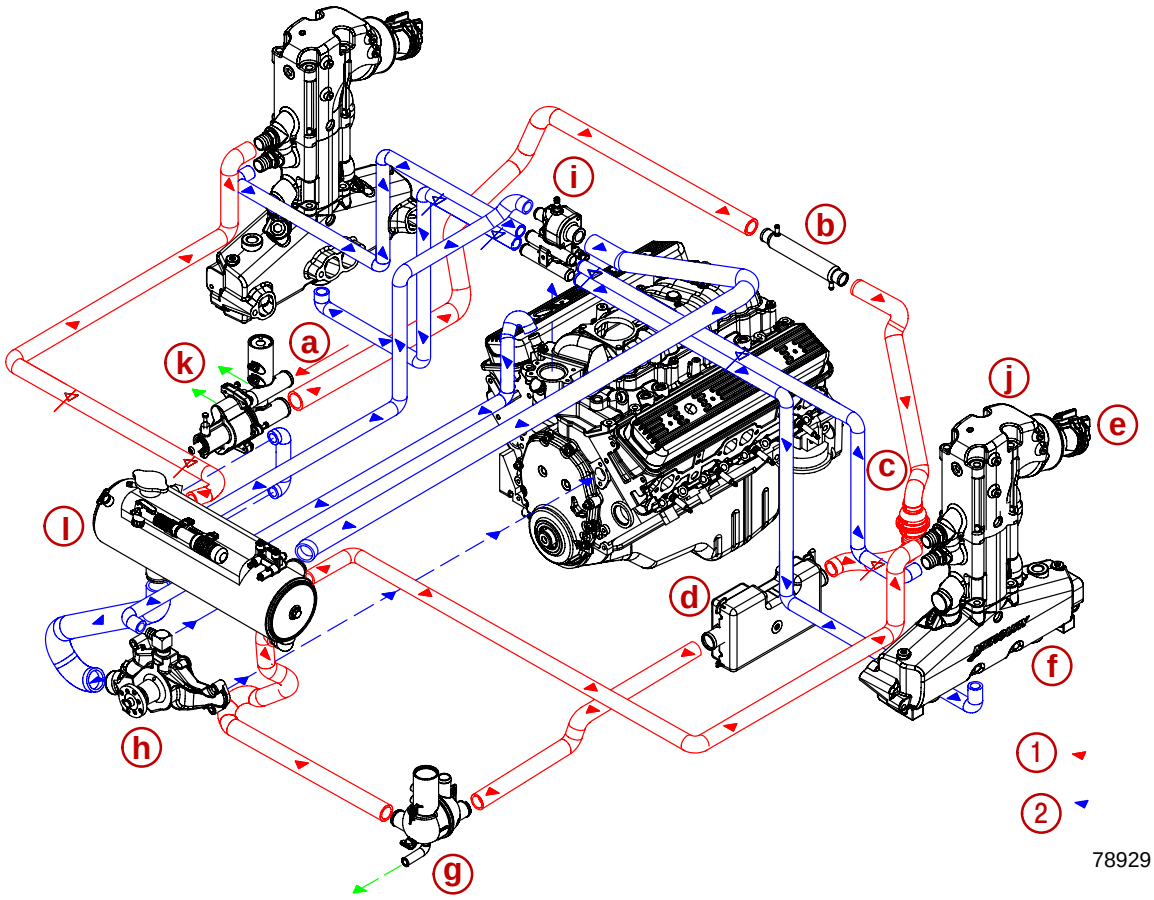


78926

a - Seawater inlet
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - Exhaust elbow
k - Seawater pump
l - Heat exchanger

1 - Seawater
2 - Ethylene glycol mix

Sterndrive With Warm Risers 0M615000 and Above

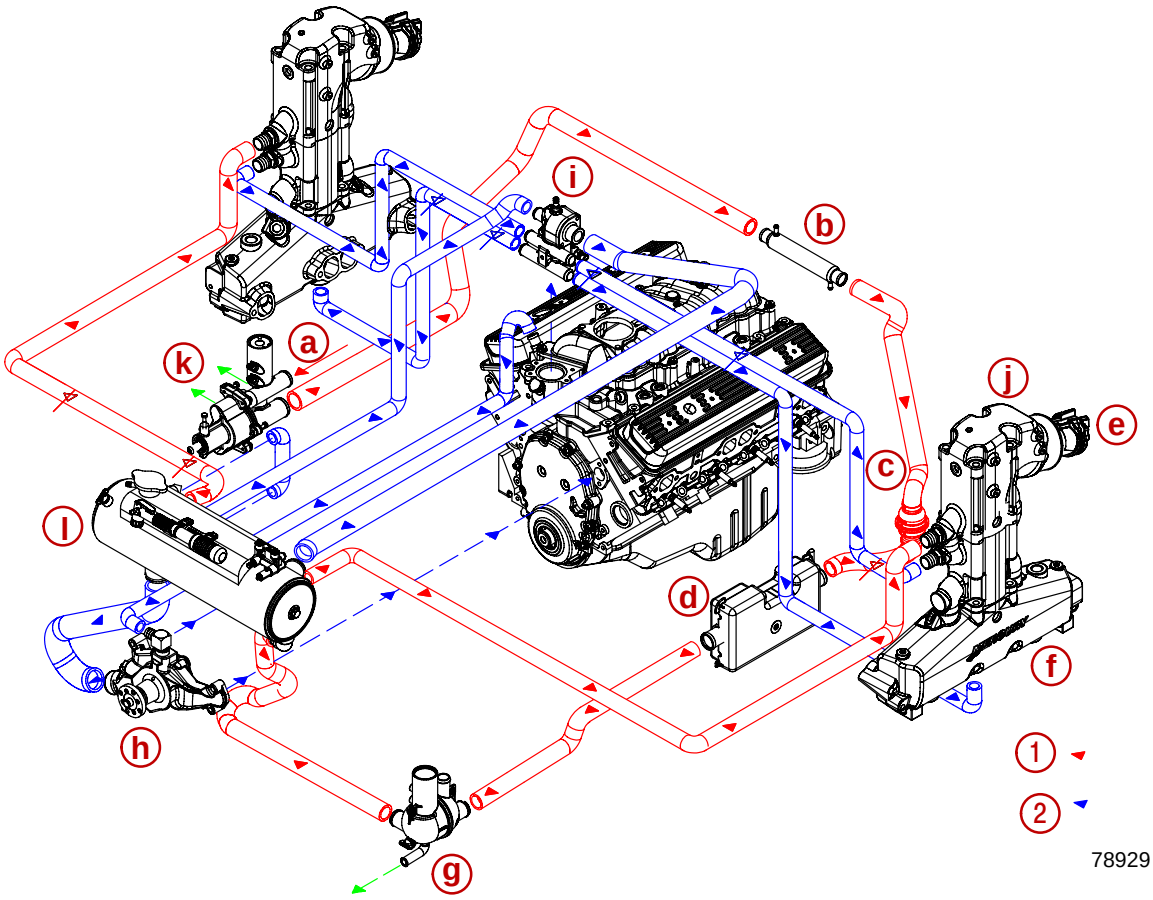


a - Seawater inlet
b - Power steering cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing

h - Water circulating pump
i - Thermostat housing
j - 14 degree inboard exhaust elbow shown (7 degree similar)
k - Seawater pump
l - Heat exchanger

1 - Seawater
2 - Ethylene glycol mix

Inline Inboard With Warm Risers 0M390000 and Above

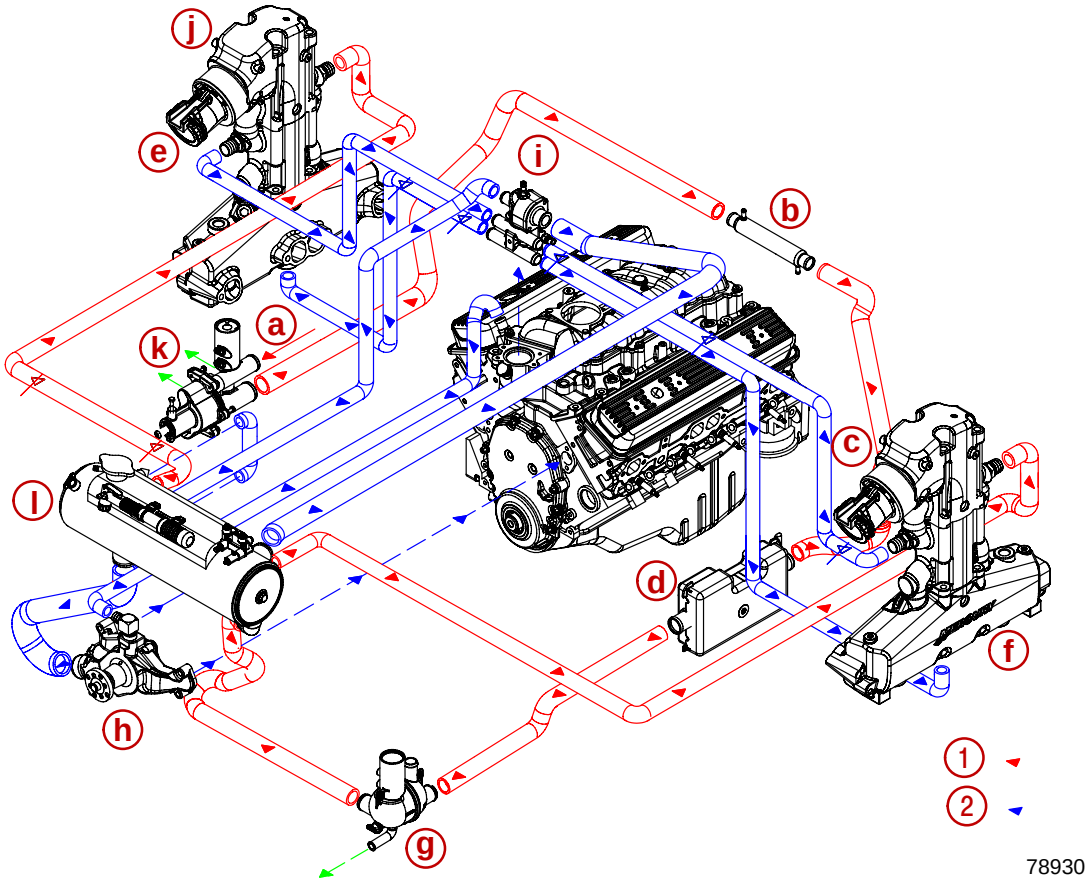


a - Seawater inlet
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing

h - Water circulating pump
i - Thermostat housing
j - 14 degree exhaust elbow
k - Seawater pump
l - Heat exchanger

1 - Seawater
2 - Ethylene glycol mix

V-drive Inboard With Warm Risers 0M390000 and Above



a - Seawater inlet
b - Transmission cooler
c - Check valve
d - Fuel cooler
e - Exhaust and seawater outlet
f - Exhaust manifold
g - Distribution housing
h - Water circulating pump
i - Thermostat housing
j - Exhaust elbow
k - Seawater pump
l - Heat exchanger

1 - Seawater
2 - Ethylene glycol mix